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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 284

Contribution from the Office of Public Roads and Rural Engineering
LOGAN WALLER PAGE, Director

Washington, D. C. ▼ September 17, 1915

CONSTRUCTION AND MAINTENANCE OF ROADS AND BRIDGES

From July 1, 1913, to December 31, 1914

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WASHINGTON
GOVERNMENT PRINTING OFFICE
1915

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INTRODUCTION.

Owing to the fact that the active field work of the office accords better with the calendar year than with the fiscal year, it has been thought best to report herein the work of the Divisions of Construction, Maintenance, and National Park and Forest Roads for the past 18 months, and in the future to have the reports cover the calendar years. This bulletin takes up the field work of the above three divisions where Department Bulletin No. 53 (Object Lesson and Experimental Roads, and Bridge Construction, 1912–13) left off. These three divisions have been formed from the one division of engineering since Bulletin 53 was issued, and the records of work divided accordingly.

As mentioned in Bulletin No. 53, the Office of Public Roads and Rural Engineering is empowered by a provision of the agricultural act to expend a portion of its appropriation " for investigations of the best methods of road making and the best kinds of road-making materials, and for furnishing expert advice on road building and maintenance."[1] In the interpretation of this clause the desire of the office has been to demonstrate in a practical way the need for good roads, as well as the benefits derived from them, and at the same time to show to the various communities the best and most economical methods of road and bridge construction and maintenance.

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[1] Agricultural act, 1914, Public No. 430, 62d Cong., 3d sess., approved Mar. 4, 1913.

The work consists in furnishing upon the request of the local officials the services of one or more engineers to make surveys, estimates, and specifications for road improvements, and to supervise the construction, in addition to giving practical advice to the local authorities, who must furnish all machinery, materials, and labor.

WORK OF THE DIVISION OF CONSTRUCTION.

The work of the Division of Construction, of which Vernon M. Peirce is chief, comprises the following projects: Construction of object-lesson roads, construction of experimental roads, construction of post roads, superintendence of county roads, design and inspection of bridges and culverts.

OBJECT-LESSON ROADS.

Short stretches of various kinds of roads in different communities have been constructed, upon application from local road authorities, as object lessons, for the purpose of demonstrating the proper materials and methods of construction in the respective communities. Forty object-lesson roads have been built during the period from July 1, 1913, to December 31, 1914. A detailed account of each one follows, given in order of the type of construction, the more expensive forms first. Under these types the roads are given alphabetically by States, counties, and towns.

CEMENT-CONCRETE ROAD.

PRINCE EDWARD COUNTY, FARMVILLE, VA.—Work was begun on a cement-concrete road extending from Farmville toward Hampden Sidney on September 25, 1913, and completed October 18, 1913, with a loss of one day on account of rain. The surrounding land is rolling and the soil a red clay. The road was graded 24 feet wide in both cuts and fills for a distance of 1,450 feet. The earth was loosened with plows and hauled with slip scrapers, wheel scrapers, and wagons. A steam roller was used on the subgrade. The road was surfaced with concrete 16 feet wide for a distance of 515 feet, making an area of 916 square yards. The thickness is 7 inches at the middle and 5 inches at the sides. The mixture used was 1 part cement, 2 sand, and 4 gravel. Expansion joints of two strips of two-ply tar paper were placed every 25 feet.

One 18-inch 28-foot corrugated-iron pipe culvert was placed at a cost of $32. The total cost of the work, excluding the pipe culvert, was $1,413.13, or $1.137 per square yard. Labor was $1.50 per day and teams $4 per day of 10 hours. The principal items of cost were: Excavation and embankment, $537.40; rent of roller, five days, at $5 per day, $25; 3 tons of coal, at $4.35 per ton, $13.05; cement, 170 barrels, at $1.83 per barrel, $311.10; sand, 50 cubic yards, at $0.10 per cubic yard, $5; loading and hauling sand to road, $0.66 per cubic yard, $33; gravel, f. o. b. cars at siding, 125 tons, at $1.60 per ton, $200; loading and hauling gravel, 1½ miles, $0.379 per ton, $47.38; rent of concrete mixer, six days, at $4 per day, $24; coal for mixer, 2 tons, at $4.35 per ton, $8.70; mixing and placing concrete, at $0.199 per square yard, $182.37; setting forms, $15.63; and miscellaneous labor, $10.50.

BITUMINOUS-MACADAM ROADS.

Dade County, Lemon City, Fla.—Work was conducted on an experimental object-lesson road beginning about one-fourth mile north of Lemon City, on the Biscayne Drive, during January and February, 1914. The work consisted of the construction of five sections of bituminous-macadam road; the stone was a local coralline rock, with various bituminous materials for the top coat. The surfaced width was 18 feet and the length 334.4 feet, making a total area of 668.8 square yards.

The total cost of the work was $420.77, or $0.629 per square yard.

Detailed description will be found in Progress Report of Dust Prevention and Road Preservation for 1914.[1]

Palm Beach County, West Palm Beach, Fla.—Work was conducted on an experimental object-lesson road beginning at a point about 2 miles south of West Palm Beach, on the Miami-Quebec Highway, during April, 1914. The work consisted of the construction of seven sections of bituminous-macadam road. The stone was a local coralline rock, with various bituminous materials for the top coat. The surfaced width was 15 feet and the length 860 feet, making a total area of 1,433 square yards.

The total cost of the work was $808.17, or $0.564 per square yard.

A detailed description will be found in Progress Report of Dust Prevention and Road Preservation, 1914.[1]

Augusta County, Staunton, Va.—Work was begun on a road leading from Staunton toward Middlebrook on September 16, 1913. This office furnished a representative for the purpose of instructing the local authorities in applying the bituminous surface. He superintended the laying of one kind of bituminous material and turned this one section over to the local authorities on September 29, 1913, with 2½ days lost due to bad weather.

When the office representative arrived this road had been graded 21 feet wide in both cuts and fills for a length of 1,700 feet. The subgrade, 15 feet wide, had been prepared, the shaping was practically done, and most of the first course of rock had been placed.

The adjacent land is rolling and the natural soil is clay and rock. The crushed rock was a limestone with good binding qualities and a fair wearing quality. It was loaded into wagons by gravity from the bins, hauled about three-quarters of a mile, and dumped on the road in piles and spread with rakes and shovels.

On the prepared subgrade the No. 1 stone, ranging from 2 to 3½ inches in size, had been spread to a depth of 5 inches and rolled until compacted to 3½ inches. On this course was spread 3 inches of loose No. 2 stone, ranging from three-fourths inch to 2 inches in size, and rolled until compacted to 2 inches. The bituminous binder was spread on this course at the rate of 1½ gallons to the square yard. This was covered with screenings varying from one-fourth to three-fourths inch in size. The road was then rolled, and a seal coat of about one-half gallon of bituminous binder applied. The binder was delivered in a tank car and heated by steam from a pump station of the Chesapeake & Ohio Railroad. At the time of the departure of the office representative 2,106 square yards of bituminous surfacing was entirely completed, 270 tons of No. 2 stone and 63.83 tons of screenings had been spread, and 5,338 gallons of bitumen used.

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[1] Bulletin No. 257, U. S. Dept. of Agriculture.

The equipment consisted of a 10-ton roller, a 700-gallon distributor wagon, rattan brooms, etc. State convicts were employed as laborers. Their labor was valued at $1 per day of 10 hours. The teams were hired at $3 per day; roller at $5 per day; roller man at $2 per day; night watchman and subforeman at $2 per day.

The cost of the bituminous surface, including No. 2 stone and screenings, was $1,069.44, or at the rate of $0.507 per square yard. The principal items of cost were as follows: Trimming shoulders, $0.80; stone in the bins at $1 per cubic yard, $333.83; hauling stone to road at $0.178 per cubic yard, $59.40; spreading No. 2 stone at $0.075 per cubic yard, $20.40; spreading screenings at $0.218 per cubic yard, $13.90; rolling, including labor, rent, and fuel, at $0.007 per square yard, $22.05; general expenses, $7.50; demurrage on tank car, $11; bituminous material at $0.09 per gallon, $480.42; unloading and hauling same at $0.0025, $13.40; heating bitumen, including depreciation of equipment, $62.04; spreading bitumen, $27.50; sweeping surface, $3.60; patching, $0.60; cost of steam, $13.

BITUMINOUS RESURFACING.

Lee County, Fort Myers, Fla.—Work was begun resurfacing the McGregor Boulevard leading from Fort Myers toward Punta Rassa on April 29, 1914, and completed May 7, 1914. The road was built with shell and given a bituminous surface treatment in the fall of 1912 under the supervision of this office.[1] From the time of the construction in 1912 to the resurfacing in May, 1914, the road was practically without maintenance or repair.

The surface was prepared by sweeping it clean with a street sweeper and hand brooms, and the grass was scraped from the roadsides with a grader. The oil was hauled an average of 2¼ miles and applied from a 500-gallon gravity distributor to the hard, dry, clean surface. It was allowed to stand until absorbed, and then covered with a thin coat of sand. One-half of the road was treated at a time in order to allow traffic the uninterrupted use of the road. The average rate of application was 0.246 gallon per square yard. The sand, obtained from the roadside, was screened, and spread to a depth of about three-sixteenths of an inch.

The road was treated for a width of 16 feet and a length of 8,950 feet, or an area of 15,911 square yards. Labor was $1.80 per day, and teams $5 per day of nine hours. Oil cost $0.0575 per gallon f. o. b. tank cars at Fort Myers. The total cost of the work was $478.51, which is at the rate of $282 per mile, or $0.0301 per square yard. The principal items of cost were preparing surface, $0.0029 per square yard; cost of oil, $0.0142 per square yard; hauling and applying, $0.0013 per square yard; brooming, $0.0018 per square yard; excavating and screening sand, $0.0088 per square yard; and spreading sand, $0.0011 per square yard.

MACADAM ROADS.

Fauquier County, Rectortown, Va.—Work was begun July 7, 1913, on a macadam road extending from the depot at Rectortown north to Marshall Road, and completed November 1, 1913, with a loss of 41 days on account of bad weather. The adjacent land is rolling and the natural soil is clay from station

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[1] Described in Bul. No. 53, U. S. Dept. of Agriculture, "Object-lesson and Experimental Roads and Bridge Construction, 1912–13."

0+00 to 27+00 and solid rock from station 27+00 to 28+00. The road was graded 26 feet wide in cuts and 20 feet wide in fills for 2,800 feet. The maximum cut was 1.7 feet, the maximum fill 2.6 feet. The total amount of excavation was 1,336 cubic yards, of which 131 cubic yards was rock excavation. The maximum grade of 8 per cent was reduced to 5.8 per cent.

Earth was loosened with plows and picks, loaded with shovels, hauled with wagons and wheelbarrows, and spread with shovels. A surface of macadam was laid for 2,800 feet, 14 feet wide, making 4,355 square yards. The macadam was applied in two courses, the first-course stones ranging in size from 1½ to 3 inches and applied 5½ inches deep; the second course ranging in size from three-fourths inch to 1½ inches and applied 2½ inches deep. On this course the screenings were applied, ranging in size from dust to one-half inch. When compacted the surfacing was 6 inches in depth. The material used for surfacing was a diabase, locally known as "ironstone." It has fair binding qualities and good wearing qualities. The crusher was set up at station 10+50 and the haul from the quarry was about 50 feet; the haul of water for the crusher engine was 2,600 feet and the average haul of water for the sprinkler was 3,000 feet. Stone was brought to the crusher in wagons and wheelbarrows, crushed, stored in bins, and loaded from the bins directly into the wagons by means of a chute.

Drainage structures were constructed as follows: At 0+12 a 15-inch corrugated-iron pipe; at 9+80 a 12-inch corrugated-iron pipe; at 12+20 a 12-inch corrugated-iron pipe; at 19+00 a 3 by 6 foot concrete culvert; at 23+50 a 12-inch corrugated-iron pipe; and at 25+80 a 12-inch corrugated-iron pipe. Concrete head walls were built at all pipe ends.

The equipment consisted of a 10-ton roller, a 12-horsepower engine, and a No. 4 rock crusher.

Labor cost from $1.25 to $2.25 per day of 10 hours, and teams cost from $3 to $5. The total cost of the road was $4,215.69, which is at the rate of $0.968 per square yard. The principal items of cost were as follows: Clearing and grubbing, $23.73; excavation at $0.623 per cubic yard, $833.88; shaping at $0.02 per square yard, $90.43; culvert pipe, $103.45; labor on same, $47.30; concrete culvert, $31.55; labor on same, $76; end walls, $5.50; side walls, $208.55; excavation for culvert, $22.77; forms, $39.28; quarrying at $0.934 per cubic yard, $600.47; hauling to crusher at $0.837 per cubic yard, $347.60; crushing at $0.495 per cubic yard, $524.86; hauling, crusher to road, at $0.203 per cubic yard, $212.60; spreading at $0.106 per cubic yard, $111.51; sprinkling at $0.0066 per square yard, $32.50; rolling at $0.055 per square yard, $242.80; general expense, $162.30; trimming shoulders, $5.87; explosives, $106.67; blacksmithing, $68.11; reinforcing steel, $34.21; lumber, $25; cement, $65.50; extras, $16.61; fuel. $176.64.

CHERT MACADAM ROAD.

NEWTON COUNTY, NEOSHO, MO.—Work on a road extending from Neosho southward toward Pineville was begun November 28, 1913, and completed December 19, 1913, with a loss of 4½ days on account of bad weather. The adjacent land is hilly and the natural soil is chert and clay. For a distance of 2,000 feet the road was graded to a width of 26 feet in cuts and to a width of 22 feet in fills, for which 2,270 cubic yards of material was moved. The maximum grade was reduced from 9 per cent to 6 per cent. The material was loosened with plows and a heavy harrow, hauled in wheel scrapers, and spread with shovels. The average haul was 300 feet, with a maximum haul of 500 feet.

The surface material was a chert varying in size from dust to 2½ inches. The run of the crusher was used without screening and the material was spread in one course to a depth of 6 inches for a width of 8 feet and a length of 933 feet, making 829 square yards. About 138 cubic yards of material were used with an average haul from the crusher to the road of 630 feet. Planks 2 by 6 inches were used at the sides to secure a uniform depth of 6 inches, and against these planks shoulders were built. The surfacing material was loaded into wagons direct from the elevator, hauled in farm wagons and spread with shovels, and the surface given a crown of three-fourths inch to the foot.

The equipment consisted of fourteen wheel scrapers, four drag scrapers, two heavy grading plows, one heavy harrow, one rooter, one road grader, one 6-ton horse roller, one crusher, one 25-horsepower traction engine.

Labor cost, $1.80, and teams, $3.60 per 9-hour day. The contract for the engine at $10 per day included fuel. The total cost of the road was $1,190.43, which is at the rate of $0.222 per square yard of graded area. The principal items of cost were as follows: Plowing, at $0.14 per cubic yard, $315.02; scraping, at $0.2685 per cubic yard, $609.60; trimming banks, at $0.0322 per square yard, $38.70; blasting, at $0.6867 per cubic yard, $20.60, including $8 for dynamite; hand-breaking stone, at $1.282 per cubic yard, $42.30; trimming shoulders, at $0.028 per linear foot, $26.43; spreading stone, at $0.0587 per cubic yard, $8.10; crushing, at $0.5155 per cubic yard, $54.13; rolling, at $0.0052 per square yard, $20.80; hauling stone to crusher, varying from $0.25 to $0.30 per cubic yard, $33.35; hauling crushed stone to road, at $0.2038 per cubic yard, $21.40.

GRAVEL ROADS.

COAHOMA COUNTY, CLARKSDALE, MISS. (SECTION 1).—A gravel road leading from Clarksdale northwesterly toward Friar Point was begun on January 5, 1914, and completed January 19, 1914, with a loss of four days waiting for materials. The adjacent land is level and the natural soil a buckshot clay. A section 1,060 feet long was graded with 580 feet surfaced 20 feet wide, and 480 feet surfaced 16 feet wide, making the surfaced area 2,142 square yards. The grade of the road was not materially changed, and the average cut was but 0.5 foot with a maximum of 1 foot. The material was loosened with plows, loaded by hand into slat-bottom wagons, and hauled away. The surfacing material, which was Tishomingo gravel and novaculite, was shipped in on the cars. The gravel weighed 3,000 pounds to the cubic yard, and the novaculite weighed 2,400 to the cubic yard. The novaculite seemed to have better wearing and binding qualities than the gravel. The material was spread to a loose depth of 12 inches by means of rakes, shovels, and the drag. It was afterwards rolled with a 5-ton horse roller until the material was compacted to 8 inches. The average haul from the cars to the road was one-fourth mile. The material contained particles of stone from the size of peastone to that of cobblestone. The road was given a crown of 6 inches on the surfaced portion.

The equipment consisted of a road grader, a 5-ton horse roller, wagons, and small tools. Labor cost $1.50 and teams $4.50 per 10-hour day.

The cost of the novaculite on the cars was $1.63 per 2,000 pounds, or $1.96 per cubic yard, and the gravel $1.47½ per 2,500 pounds, or $1.77 per cubic yard. The total cost of the road to the community was $1,722.72, which is at the rate of $0.804 per square yard for the surfacing. The principal items of cost were as follows: Excavation, $71; shaping, at $0.0217 per square yard, $46.50; surfacing material, $1,191.22; loading wagons from car at $0.126 per cubic yard, $94.50; hauling from cars to road, at $0.315 per cubic yard, $236.25; spreading material, at $0.058 per cubic yard, $43.50; trimming shoulders, $16.50; rolling, at $0.011 per square yard, $23.25.

COAHOMA COUNTY, CLARKSDALE, MISS. (SECTION 2).—A second section of gravel road leading from Clarksdale northwesterly toward Friar Point was begun November 17, 1913, and completed January 29, 1914, with a loss of one day, due to bad weather. The adjacent land is slightly rolling and the soil a sandy loam throughout the entire length. A section 2,640 feet long was graded for a width of 26 feet in both cuts and fills. The gravel surface is 2,640 feet long for a width of 10 feet, making a surfaced area of 2,933 square yards. The maximum cut was 2 feet and the maximum fill 3 feet, and the material was moved with slip scrapers after being loosened with plows. The average haul was 100 feet, with a maximum haul of 600 feet. The surfacing material was Tishomingo gravel, shipped on the cars. The haul from the cars to the road was approximately 3½ miles. The material was spread by hand, using rakes and shovels. The material wears well under moderate traffic, but tends to lose its binding quality in dry weather.

The gravel was spread in one course to a depth of 9 inches and compacted to 6 inches by aid of a roller. The gravel ranged in size from that of cobblestone to peastone. It is estimated that 867 cubic yards of gravel were used.

As completed, the road has a 4-foot shoulder of earth on one side and a 12-foot earth roadway on the other, with the finished surface having a crown of 1 inch to 1 foot. One cross drain, 25 feet long, of 12-inch clay pipe was laid at station 52+00.

The equipment consisted of a road grader, a 5-ton horse roller, slat-bottom wagons, and small tools. Labor cost $1.50, and teams $4, including driver per 10-hour day. The total cost of the road to the community was $2,862.38, which is at the rate of $0.976 per square yard. The principal items of cost were as follows: Excavation, $197.98; shaping, at $0.02 per square yard, $59.60; 12-inch clay pipe, at $0.45 per linear foot, $11.25; labor on same, $3.25; foreman, $43.50; gravel, at $1.475 per cubic yard, $1,278.83; hauling from cars to road per contract, at $1.25 per cubic yard, $1,083.75; spreading gravel, at $0.12 per cubic yard, $88.35; rolling per square yard, at $0.015, $44.12; trimming shoulders and ditches, $51.75.

SUNFLOWER COUNTY, INDIANOLA, MISS.—A gravel road leading from Indianola northerly toward Faisonia was begun on October 14, 1913, and completed November 19, 1913, with a loss of nine days on account of bad weather and one day due to other causes. The adjacent land is level, with a buckshot soil the entire length of the road. A section 1,790 feet long was graded for a width of 24 feet. The gravel surface is 16 feet in width for the entire length, giving an area of 3,182 square yards. The grade of the road was not materially changed, the average fill was but 0.8 foot, and the maximum 1.83 feet. It is estimated that 1,337 cubic yards of material were used in the embankment. The maximum haul was 40 feet. The material was loosened by plows and moved with drag scrapers.

The surfacing material was shipped in by rail a distance of 243 miles, and was the pit-run of gravel with good wearing qualities, but with varying binding qualities, and the gravel required careful spreading. It was applied in one course for a depth of 10½ inches at the center and 8 inches at the sides before compacting. The crown of the road was five-eighths inch to the foot.

The equipment consisted of a 10-ton tractor roller and drag scrapers. The surfacing material, of which 997 cubic yards were used, was delivered on the cars at the contract price of $1.46 per cubic yard, making it cost $1,452.60 at the siding. Labor cost $1.50 per day, and teams, including driver, $3.50 per day, based on a 10-hour day. The total cost of the road to the community was $2,218, which is at the rate of $0.697 per square yard. The principal items of cost were as follows: Embankment, at $0.131 per cubic yard, $175.20; shaping the subgrade, at $0.005 per square yard, $19.50; gravel on siding, at $1.46 per cubic yard, $1,452.60; hauling and loading gravel, at $0.332 per cubic yard, $331; spreading gravel, at $0.035 per cubic yard, $34.95; rolling gravel, at $0.0026 per square yard, $8.25; rolling subgrade, $3.60; building shoulders, $14.25; equipping wagons, $1.05; general expenses, $111; rehandling gravel to save demurrage, $66.60.

RANDOLPH COUNTY, ASHEBORO, N. C.—A gravel road leading from Asheboro north toward Randleman was begun November 14, 1913, and entirely completed December 19, 1913, with two days lost on account of bad weather and one day from other causes. The adjacent land is hilly and the natural soil yellow clay from station 0+00 to 14+00; rock and yellow clay from station 14+00 to 17+00; yellow clay and some rock from station 17+00 to 24+00. A section 2,400 feet long was graded 25 feet wide in cuts and 22 feet in fills. The gravel surface is 2,400 feet long and 10 feet in width, making an area of 2,667 square yards. Three wooden box culverts were constructed, each 1 by 1.5 feet by 24 feet long. One 4-inch tile was used for road drainage between stations 1+75 and 2+50.

The maximum grade was reduced from 8 per cent to 5 per cent. The maximum cut was 4.8 feet, and the maximum fill was 2 feet. Nine hundred and seventy-six cubic yards of earth were excavated, with an average haul of 150 feet and a maximum haul of 400 feet. In addition, about 47 cubic yards of rock were removed. This material was loosened with picks, plows, and dynamite, hauled in wagons and slip scrapers, and spread with shovels and road grader.

The surfacing material was gravel containing about 60 per cent quartzite with top soil and clay. It was hauled about 1,000 feet and spread with stone forks. The gravel appears to have good binding and wearing qualities. The gravel was applied in one course to a depth of 6 inches before compacting, and the size of the particles ranged from dust to 3 inches. Four hundred and forty-four cubic yards of gravel were used, of which 290 cubic yards were purchased. The crown of the road, as finished, was three-fourths inch to the foot.

The equipment consisted of a road grader and drag scrapers.

Labor cost $1.25 to $1.50, and teams $2.50, based on a 10-hour day. The total cost of the road to the community was $520.15, which is at the rate of $0.195 per square yard. The principal items of cost were as follows: Excavation, at $0.258 per cubic yard, $264.24; shaping, at $0.0056 per square yard, $15; culvert materials, $5.50; labor on same, $3.12; clearing and grubbing, $11.44; gravel, at $0.1034 per cubic yard, $30; loosening and loading, at $0.138 per cubic yard, $61.25; hauling from pit to road, at $0.1267 per cubic yard, $56.25; spreading gravel, at $0.0301 per cubic yard, $13.38; shaping same, at $0.0075 per cubic yard, $20; trimming shoulders, $0.0062 per linear foot, $15; general expenses, $16.25; explosives, $8.72.

KINNEY COUNTY, BRACKETTVILLE, TEX.—Work was begun surfacing with gravel the Spofford road, extending south from Brackettville toward Spofford, on April 23, 1914, and completed May 6, 1914, with no time lost from any cause. The adjacent land is rolling and the soil is black lime, with a small amount of chalk throughout. The road was graded 36 feet wide in both cuts and fills and was 1,500 feet in length. There was practically no excavation or fill, the earth was loosened by plows drawn by tractor and hauled and spread by two graders drawn by tractor. The maximum fill was 0.5 foot and the total excavation did not exceed 500 cubic yards. The maximum grade was 2 per cent.

A surface of gravel was laid for 1,500 feet, 16 feet wide, making 2,667 square yards. The gravel was applied in one course with a loose thickness of 8 inches at the center and 4 inches at the sides, with a crown of 6 inches. The material was dumped between 2 by 4 inch planks on edge at sides and the shoulders were built up against the edge of gravel. All the gravel used for surfacing passed a 3-inch ring, had fair binding and wearing qualities, and was obtained from a pit at an average haul to the road of three-fourths of a mile. No water was used on the road during the rolling, which was done with a 6-ton horse roller. The gravel was hauled by farm wagons of 1 cubic yard capacity and Troy dump wagons of 3½ cubic yards capacity hauled by a tractor.

The equipment consisted of one 20-horsepower gasoline tractor, two extra heavy graders, six 3½-yard wagons, a 6-ton horse roller, two rooters, two road plows, four drag scrapers, and one steel road drag. Labor cost $1.20 per day of eight hours and teams $3 per day. The total cost of the road was $460.60, which is at the rate of $0.1727 per square yard, or $1,621.31 per mile.

The principal items of cost were as follows: Plowing and grading, $0.328 per square yard of finished surface; rolling subgrade, $0.0017 per square yard; loosening and loading gravel, $0.3447 per cubic yard; hauling gravel, $0.3981 per cubic yard; spreading gravel, $0.0584 per cubic yard; rolling gravel, $0.0014 per square yard; trimming shoulders and ditches, $0.0056 per linear foot.

CALDWELL COUNTY, LOCKHART, TEX. (No. 1).—Work was begun on a gravel road extending south from Lockhart toward Seawillow on the Gonzales road May 28, 1914, and completed on August 7, 1914, with a loss of four days on account of bad weather. The adjacent land is rolling and the natural soil was as follows: *Section 1*—Station 0+00 to 7+00, black waxy; station 7+00 to 28+00, gray adobe; station 28+00 to 40+00, clay gravel; station 40+00 to 49+00, limestone, gravel, and black dirt. *Section 2*—Station 0+00 to 32+00, white adobe. The road was graded 36 feet wide in cuts and 20 feet wide in fills. The maximum cut was 1.5 feet and the maximum fill 2.5 feet. No change was made in maximum grades. Earth was loosened with plows, hauled by Fresno scrapers, and shaped with a blade grader.

A surface of gravel 14 feet wide was laid for 8,975 feet, making 13,961 square yards. The gravel was applied in two courses, the first course from 1½ to 3 inches in size and applied 6 inches loose depth; the second course from sand to 1½ inches, applied 3½ inches loose depth. When completed the surfacing was 7¾ inches deep. The material used for surfacing was a pit sand-clay gravel with good binding and wearing qualities. The average haul for both gravel and water for sprinkling was 2,000 feet. The gravel was loaded with slip scrapers through a loading trap into slat-bottom wagons and was spread with a grader.

Drainage structures were built as follows: One 18-inch by 22-foot corrugated pipe culvert; six 24-inch by 22-foot corrugated pipe culverts; three 30-inch by 22-foot corrugated pipe culverts; and one 36-inch by 8-foot culvert. Twenty-nine barrels of cement and 31 cubic yards of gravel were used in head walls.

The road equipment consisted of Fresno scrapers, road grader, slip scrapers, and slat-bottom wagons.

Labor cost $2 per day and teams $4 per day of 8 hours. The total cost of the road was $2,676.69, or $0.1770 per square yard, and at the rate of $1,453.70 per mile. The principal items of cost were as follows: Culverts complete, $667.37; clearing and grubbing, $4.80 per acre; excavation, $0.1959 per square yard; shaping subgrade, $0.0027 per square yard; concrete end walls, $5.10

per cubic yard; surfacing material in pit, $0.07 per cubic yard; loading gravel with slip scrapers through trap, $0.1571 per cubic yard; hauling gravel 2,000 feet and dumping, $0.2021 per cubic yard; spreading gravel with grader, $0.0181 per cubic yard; finishing, $0.0005 per square yard; general expenses, including superintendent, $108.

Caldwell County, Lockhart, Tex. (No. 2).—A second gravel object-lesson road was built at Lockhart, Tex., on the League Line Road, extending southwest from Burdett Wells Road toward Luling. Work was begun on March 5, 1914, and completed July 7, 1914, with a loss of 46 days on account of bad weather and 9 days for other causes. The adjacent land is rolling, and the soil from station 0 to 56+50 is "black waxy"; station 56+50 to 65+00, chocolate loam; and from station 65+00 to 82+00, "black waxy." The road was graded to a width of 36 feet in cuts and 20 feet in fills for a length of 9,680 feet. The maximum cut was 1.5 feet and the maximum fill was 7 feet. The maximum grade of 4 per cent was reduced to 3 per cent. Earth was loosened with plows, handled with Fresno scrapers, and shaped with a road machine.

The sand-gravel surfacing was loaded into slat-bottom wagons through a loading trap and hauled an average distance of 3,000 feet to the road, where it was spread to a width of 14 feet, making a surfaced area of 15,058 square yards. Two courses were laid, as on the Gonzales Road previously described.

Drainage structures were built as follows: Five 30-inch corrugated-iron pipe culverts 22 feet long, and two 36-inch corrugated-iron pipe culverts 22 feet long, all with concrete head walls containing a total of 26 barrels of cement and 26 cubic yards of pit-run gravel.

The road equipment used consisted of a road grader, three Fresno scrapers, six slip scrapers, and slat-bottom wagons.

Labor cost $2 per day and teams $4 per day. The total cost of the road was $3,426.52, or $0.2275 per square yard, which is at the rate of $1,868.46 per mile. The principal items of cost were: Clearing and grubbing, $16.72 per acre; excavation, $0.2625 per square yard; shaping subgrade, $0.0035 per square yard; culverts, including material and labor, $452.87; surfacing material in pits, $0.05 per cubic yard; loading, $0.1573 per cubic yard; hauling, $0.2582 per cubic yard; spreading gravel, $0.0098 per cubic yard; shaping gravel, $0.0007; right of way, $117, which is at the rate of $125 per acre; general expenses, $91.50.

Comal County, New Braunfels, Tex.—Work was begun on a gravel road extending southeast from New Braunfels toward Seguin on March 13, 1914, and completed May 28, 1914, with a loss of 25 days on account of bad weather. The adjacent land is rolling, and the nature of the soil is "black waxy." The road was graded 30 feet wide in both cuts and fills for a distance of 4,600 feet. A road machine was used to do all the grading, as it was light work. The maximum grade of 2.3 per cent was reduced to 1.275 per cent.

The gravel surfacing was obtained from pits, hauled an average of three-fourths of a mile, and spread to a width of 16 feet, making a surfaced area of 8,177 square yards.

One 12-inch and one 24-inch corrugated-metal pipe culvert 22 feet long were laid.

The total cost of the work was $1,786.36, or $0.218 per square yard. The principal items of cost were clearing and grubbing, $3; grading, $226.75; gravel ready for use, including stripping pits and drilling, 2,272 cubic yards, at $0.179 per cubic yard, $752.15; explosives, caps, etc., $101.40; loading and hauling 2,272 cubic yards of gravel, at $0.247 per cubic yard, $562.50; spreading gravel, at $0.033 per cubic yard, $75.06; rolling, $5; shaping, $45; and culverts, $15.50.

UVALDE COUNTY, UVALDE, TEX.—A gravel road leading from Uvalde eastward toward Sabinal was begun January 24, 1914, and abandoned February 6, 1914, for lack of funds. The adjacent land is rolling, with brown clay from station 0+00 to station 22+00; soft rock from station 22+00 to station 35+00; black clay loam from station 35+00 to station 57+00. A section 4,300 feet long was graded for a width of 32 feet in both cuts and fills. The gravel surface is 2,200 feet long and 16 feet wide, making a surfaced area of 3,911 square yards. One timber bridge having a 15-foot span was constructed at station 42+00.

The maximum grade was reduced from 6.4 per cent to 4.2 per cent, the maximum cut was 2.8 feet, and the maximum fill 2.9 feet. Approximately 652 cubic yards of gravel were used, spread 10 inches deep at the center, and feathered to 0 at the edges. The gravel was spread 16 feet wide and finished with a crown of 1 inch to the foot.

Labor cost $1.50 and county teams $1 per 8-hour day. The total cost of the road to the community was $622.13, which is at the rate of $0.159 per square yard for the surfacing. The principal items of cost were as follows: Excavation, $94.25; loosening and loading gravel, $8.50; hauling gravel, $305.60; spreading gravel, $36; finishing, $16.25; bridge excavation, $33.75; lumber, $86.78; labor on bridges, $41.

SAND-CLAY ROADS.

DUKES COUNTY, TISBURY, MARTHAS VINEYARD, MASS.—During the month of August, 1913, a section of the Makonikey Road in the town of Tisbury, originally very sandy, was surfaced 16 feet wide with natural sand clay or top soil to a uniform loose depth of 9 inches. This was compacted partly by the traffic and partly by means of a light stone roller and the drag. The length of the section was 320 feet, making 569 square yards, and the total cost was $75.38, which is at the rate of $0.132 per square yard.

Two-wheeled dump wagons were used for hauling the top soil, and the average load was 24 cubic feet. The average haul was 2,850 feet.

Another section of object-lesson road was constructed on the crossroad from Chilmark Post Office to Menemsha Creek by surfacing with a sand-clay mixture. After shaping the subgrade clay was hauled and spread to a width of 16 feet and a uniform loose depth of 8 inches, then covered with sand to a depth of 4 or 5 inches. The material was thoroughly cut up by plowing and disk harrowing, then by a spiked-tooth harrow followed by disking and shaping with a plank drag. The road was at this time in a loose and powdery condition, but mechanically well mixed. It rained shortly after the completion of this part of the work, and the section was then rolled and dragged, with excellent results.

The total length of this section was 180 feet, making 320 square yards, and the total cost $89.75, which is at the rate of $0.280 per square yard. The price could be reduced one-third if a greater length were built, with a better organized working force.

DUKES COUNTY, GAY HEAD, MASS.—The improvement of the State Road, extending west from Chilmark toward Gay Head Light, was begun on December 3, 1913, and completed on June 8, 1914, after a loss of 12½ days on account of bad weather and 101 days, from January 11 to April 21, 1914, when work was discontinued during the winter. The adjacent land is rolling and composed of successive stretches of sandy loam, fine sand, clay, and a natural sand-clay mixture.

A section 11,600 feet in length was graded 22 feet wide in both cuts and fills. The maximum cut was 3 feet and the maximum fill 4 feet. The road was surfaced 16 feet wide with a sand-clay mixture, making 20,622 square yards. Where the subgrade was sand, clay was added, and vice versa. The surfacing was laid about 6 inches in depth. For several short stretches the natural soil was a sand-clay mixture and required no other surfacing material.

The drainage structures were: Twelve vitrified-clay pipes, ranging in size from 8 to 15 inches in diameter and totaling 342 feet in length, and 1 blind stone drain 2 feet wide, 2 feet deep, and 100 feet in length.

The total cost of the work was $3,506. Labor cost $2 per day and teams $5 per day of 9 hours. The principal items of cost were: Excavation (earth), 2,651 cubic yards at $0.45 per cubic yard, $1,193.28; excavation (rock), 22 cubic yards at $1.25 per cubic yard, $27.55; trimming shoulders and ditches, $69.23; and superintendence, $90—making a total cost of grading of $1,380.06. Stripping for sand, $9.22; stripping for clay, $31.64; loading and hauling sand, 1,700 cubic yards at $0.223 per cubic yard, $378.39; loading and hauling clay, 2,300 cubic yards at $0.344 per cubic yard, $791.76; spreading sand and clay, 24,350 square yards at $0.003 per square yard, $73.70; mixing 20,622 square yards of sand and clay at $0.010 per square yard, $199.52; shaping and crowning 20,622 square yards at $0.004 per square yard, $90.57; superintendence, $118.46; and 1,050 cubic yards of clay at $0.08 per cubic yard, $84—making a total cost of surfacing $1,777.26, or $0.090 per square yard. Miscellaneous labor cost $83.46; excavation for pipe culverts, $34.72; hauling materials, $5.08; placing pipe and backfilling, $24.02; 32 linear feet of 15-inch vitrified-clay pipe at $1 per foot, $32; 234 linear feet of 12-inch vitrified-clay pipe at $0.60 per foot, $140.40; 28 linear feet of 10-inch vitrified-clay pipe at $0.40 per foot, $11.20; and 48 linear feet of 8-inch vitrified-clay pipe at $0.30 per foot, $14.40; cement, $340—making a total of $265.22 for 342 linear feet of vitrified-clay pipe in place, or $0.775 per linear foot.

NORTHAMPTON COUNTY, JACKSON, N. C.—Work was started on the Church Street Extension Road, which leads north from Jackson toward Seaboard, on September 4, 1913, and was completed on November 3, 1913. Seven days were lost on account of bad weather and one day from other causes. The weather and labor conditions added materially to the cost of the work. The land adjacent to the road is comparatively level and the soil is yellow clay mixed with fine sand.

The improvement consisted in grading and shaping the existing road and surfacing it with a sand-clay mixture that contained about 25 per cent of gravel. The soil was loosened with plows and picks, hauled in drag scrapers, and spread by the scrapers and grader. The maximum cut was 1.1 feet and the maximum fill 1.3 feet. The maximum grade was reduced from 3.3 to 1.7 per cent.

One corrugated-iron pipe, 24 inches in diameter and 26 feet long, was laid, and two corrugated-iron pipes were laid at driveways, both 20 feet long and 12 and 15 inches, respectively, in diameter. Head walls of concrete were placed at the ends of the largest pipe.

Surfacing material was hauled about 1 mile and consisted of about 50 per cent sand, 25 per cent clay, and 25 per cent gravel. It was hauled in dump wagons and spread by hand labor and by the road drag. When compacted the material was 7 inches at the center and 4 inches at the sides, with a width of 14 feet surfaced. The crown of the road was four-sevenths inch to the foot.

The road was graded to a length of 2,500 feet, with a width of 30 feet in both cuts and fills, and surfaced for 2,400 feet to an average width of 14 feet, making the surfaced area 3,733 square yards. Earth to the amount of 680 cubic yards was moved in excavation and 890 cubic yards of surfacing material was used.

The equipment consisted of one reversible road grader, three Twentieth Century road drags, one dump wagon, seven drag scrapers, one turning plow, one hardpan plow, one 3½-ton horse roller. Labor cost $1.25 per 10-hour day.

The total cost of the road to the community was $1,193.22, which is at the rate of $0.32 per square yard. The principal items of cost were: Excavation, 680 cubic yards, at $0.30 per cubic yard, $205.18; shaping subgrade, at $0.002 per square yard, $10; culvert pipe delivered, at $1.69 per linear foot, $44; labor on the same, $0.44 per linear foot, $9.10; drain pipe at driveways, $0.94 per linear foot, $37.75; labor on the same, $0.20 per linear foot, $8.10; labor on end walls, $1.71; excavation on end walls, $10.80; surfacing material, 890 cubic yards, at $0.005 per cubic yard, $4.45; loading the same, $0.26 per cubic yard, $235.25; hauling the same, $0.58 per cubic yard, $517.64; spreading the same, $0.077 per cubic yard, $68.25; rolling the same, $1.97; dragging road, $0.002 per square yard, $6.33; stripping pit, $25.90; cement, $3.09 per barrel, $4.63; sand for concrete, $1.67 per cubic yard, $0.72; gravel for concrete, $1.67 per cubic yard, $1.44.

Burke County, Morganton, N. C.—Work was begun on a sand-clay road leading from Morganton to Lenoir on May 19, 1913, and completed on July 26, 1913, with a loss of one day on account of bad weather and one day from other causes. The adjacent land is hilly and the soil is red clay from station 0+00 to 5+50; a red micaceous clay from station 5+50 to 15+50; a red clay from station 15+50 to 22+00; a micaceous clay from station 22+00 to 26+00; a gray top soil over red clay from station 26+00 to 42+00; and micaceous clay from station 42+00 to 57+00. A total length of 5,700 feet was graded 25 feet wide in cuts and 22.5 feet wide in fills.

Earth was excavated to the amount of 8,960 cubic yards, with an average haul of 100 feet and a maximum haul of 700 feet. In addition, about 15 cubic yards of rock were removed. The road was surfaced 20 feet wide for 1,400 feet, making 3,111 square yards. On the graded road was placed 9 inches of sand at the center and 6 inches at the sides, and over this a course of clay 3 inches thick at the center and 2 inches thick at the sides was spread. The two materials were then mixed by means of a disk harrow.

Sixteen pipe culverts, varying in size from 12 to 24 inches, were constructed, and the ends protected with masonry head walls.

The equipment consisted of a road grader, four wheel scrapers, seven slip scrapers, one rooter plow, one road plow, and one disk harrow. The total cost of the road was $1,555.95, including culverts, or at the rate of $0.0991 per square yard. The principal items of cost were as follows: Excavation, at $0.0879 per cubic yard, $787.90; shaping, at $0.0069 per square yard, $87; culvert pipes, $223.25; labor on the same, $73.80; loading sand, $0.021 per cubic yard, $13.80; hauling sand, $0.084 per cubic yard, $54.37; loading clay, $0.021 per cubic yard, $4.50; hauling clay, $0.121 per cubic yard, $26.12; spreading, mixing, and finishing, $28.01; clearing and grubbing, $96.80; moving fence, $15.90; sidehill ditches, $9.50; general expenses, $135. Labor cost is based on $1, and teams at $2.50 per day of 10 hours. A bond issue of $50,000 is available to continue this work.

Edgecombe County, Tarboro, N. C.—Work was begun on a sand-clay road extending from Tarboro southward toward Conetoe on October 21, 1913, and completed December 20, 1913. The adjacent land is level, and the natural soil from station 24+54 to 50+00, sandy with a clay subsoil; 50+00 to 66+00, black sand; 66+00 to 156+54, sand. A length of 13,200 feet was graded 22 feet wide in both cuts and fills. Earth was excavated to the amount of 4,236 cubic yards, and the average haul was 325 feet, with a maximum haul of 1,800 feet.

Throughout its entire length the road was surfaced to a width of 18 feet, making 26,400 square yards. Clay was spread to a uniform depth of 6 inches, and 2,815 cubic yards of clay were hauled on the road. The material is inferior, but is an improvement over the previous sandy condition. A temporary wooden bridge was built at station 50+22, to be replaced later with a concrete bridge if present plans are carried out.

The equipment consisted of two graders, two plows, three harrows, wheel scraper, horse roller, and wagons. The total cost of the road was $1,867.55, which is at the rate of $0.0578 per square yard. The principal items of cost were as follows: Clearing and grubbing at $0.0217 per square yard, $167.90; excavation at $0.1174 per cubic yard, $497.40; shaping at $0.0018 per square yard, $48.30; loading and hauling clay at $0.2548 per cubic yard, $717.35; spreading clay at $0.0178 per cubic yard, $50.10; rolling at $0.00099 per square yard, $26.35; trimming shoulders and ditches, $88.90; stripping for clay at $0.012 per square yard, $6.60; mixing at $0.0024 per square yard, $63.90; finishing surface at $0.00215 per square yard, $57.60; general expenses, $19.75; temporary bridge, $10.40; livery, $78; survey, $35. The above costs are based upon a cost of $0.80 for labor and $0.80 per mule for an eight-hour day.

JONES COUNTY, TRENTON, N. C.—Work was begun on Main Street extending west from Trenton on September 6, 1913, and operations continued to October 3, 1913, when scarcity of labor prevented further progress. One day was lost on account of bad weather, and the inadequate force and bad weather also involved many delays and were largely responsible for the high cost of the work. The adjacent land is level and the soil sandy loam throughout.

The improvement consisted in grading and shaping the existing road and surfacing it with a sand-clay mixture. The road was entirely graded to a length of 3,600 feet, with a width varying from 40 to 46 feet in both cuts and fills. A portion of the road was partly graded for 7,200 feet. Part of the subgrade was prepared 15 feet in width and part 30 feet in width. This was surfaced to the extent of 3,680 square yards when the work was shut down.

The soil was loosened with plows and mattock, hauled with drag scoops, and spread with shovels and rakes. Clay to the amount of 409 cubic yards and 511 cubic yards of sand were hauled for surfacing. As the near-by material was unfit for use the clay was hauled a distance of 5,750 feet. It was spread to a depth of 4 inches on the road, and then covered with the sand, which was obtained from Trent River. The two materials were mixed by means of a plow and harrow. The road was shaped so that the crown of the finished surface was 1 inch to 1 foot.

Cross drains 30 feet long were constructed of 24-inch corrugated-iron pipe at stations 34+50 and 46+60.

The equipment consisted of plows, harrows, drags, scoops, and plank drag.

Labor cost $1 to $1.25 and teams $2 per 10-hour day.

The total cost of the road to the community was $795.11, and the cost of the completed section was $465.48, which is at the rate of $0.1265 per square yard for the finished surface. The principal items of cost were: Rough grading, at $0.009 per square yard, $80.50; stripping clay pit, at $0.077 per cubic yard, $31.50; loosening and loading clay, at $0.119 per cubic yard, $49; hauling, at $0.387 per cubic yard, $158.45; spreading, at $0.023 per cubic yard, $9.50; loading sand, at $0.034 per cubic yard, $17.50; hauling, at $0.155 per cubic yard, $79.48; spreading, at $0.015 per cubic yard, $7.25; mixing and dragging, at $0.009 per square yard, $32.30.

Duplin County, Wallace, N. C. (Section 1).—Two sections of sand-clay road were constructed in the vicinity of Wallace. Work was begun on the first section, extending northeasterly from Wallace toward Chinquapin, on September 4, 1913, and completed on September 12, 1913, with a loss of one day on account of bad weather. The adjacent land is slightly rolling, with a sandy soil over a clay strata. The total length of 2,000 feet was graded 22 feet wide in both cuts and fills, but the grade of the road was not materially changed. The average haul was 50 feet, and the hauling was done chiefly with drag scrapers.

The road was plowed to bring the clay up into the sand, and the two materials were then thoroughly mixed by means of harrows and scrapers. The finishing was done with the split-log drag. The entire length of 2,000 feet was thus treated for the full width of 22 feet.

The equipment consisted of a road scraper, a disk harrow, tooth harrow, scoops, turning plow, rooter plow, horse roller, and split-log drags.

The total cost of the road was $140.25, which is at the rate of $0.029 per square yard. The principal items of cost were as follows: Clearing and grubbing, $50.66; excavation, $22.54; mixing, $22.75; shaping, $23.60; trimming the shoulders, $15.10; explosives, $5.60. The above costs are based on a labor cost of $1.25 per day of 10 hours and a cost of $0.50 per day for each mule, not including the driver.

Duplin County, Wallace, N. C. (Section 2).—Work was begun on the second section, extending from Island Creek Bridge toward Chinquapin, on September 12, 1913, and completed on October 4, 1913, with a loss of two days on account of bad weather. The adjacent land is slightly rolling and the natural soil is mostly sand. A total length of 3,100 feet was graded 22 feet wide in both cuts and fills. The excavation amounted to 850 cubic yards and the average haul was less than 100 feet. Drag scrapers were used.

Throughout its entire length the road was surfaced to a width of 15 feet, making 5,167 square yards. The sand-clay surface was constructed by spreading the clay on the sand surface to a depth of 8 inches at the center and 6 inches at the sides. Sand was added from the slopes and gutters, and in addition to the daily use of the harrow the heavy teaming assisted in mixing the materials. The surface was finished with the split-log drag. It is estimated that about 717 cubic yards of clay were hauled to the road from the two clay pits. The binding qualities of the clay and the wearing qualities of the clay and sand appear to be very good. Five vitrified-pipe culverts were constructed, ranging in size from 10 inches to 24 inches.

The equipment consisted of a road scraper, disk and tooth harrows, log drag, plows, etc. The total cost of the road was $452.76, which is at the rate of $0.081 per square yard, exclusive of drainage structures. The principal items of cost were as follows: Grading, $182.08; explosives, $4.80; culvert materials, $27.26; labor on the same, $8.97; surfacing, $210.98; general expenses, $18.67. The above costs are based on a labor cost of $1.25 per 10-hour day and a cost of $0.50 per mule each day.

Okmulgee County, Okmulgee, Okla.—Work was begun on a stretch of the road leading south from Okmulgee toward Henryetta on June 26, 1913, and completed in about 30 days. The adjacent land is slightly rolling. The soil is generally either sand or clay, with a small amount of prairie soil. The sand occurs for the most part in the depressions, while the clay occurs on the hills.

The road was graded and surfaced 20 feet wide for a distance of 5,600 feet, or an area of 12,444 square yards. The total amount of excavation was 2,990 cubic yards and the average haul was 700 feet. The sand and clay taken from the cuts was distributed so as to obtain the correct proportion for the surfacing. Equipment used consisted of plows for loosening the earth, Fresnos for short haul, and wheeled scrapers for long haul.

The grading and surfacing was done by a railroad contractor on a labor contract. The agreed scale of wages was: Foreman, $3; timekeeper, $1; men, $2; and teams with drivers, $5 per day. The total cost was $2,045.75, or $0.164 per square yard.

Beckham County, Sayre, Okla.—Work was started on the Sayre-Delhi road, which leads south from Sayre toward Delhi, on January 28, 1914, and completed February 11, 1914, with a loss of one day due to bad weather. The land adjacent to the road is rolling and the natural soil a deep sand. No material change was made in the grade. In constructing the road deep plowing was employed to loosen the roots of the dwarf oaks and a harrow was used to collect the roots, which were thrown out by hand. The sand was then graded, and on the sand bed 1,383 cubic yards of clay were spread to a depth of 8 inches before compacting. The average haul for the clay was 7,500 feet. The clay was dumped from wagons and spread by hand. It was smoothed by the use of a drag and appears to have good wearing and binding qualities. Due to the weather and high winds, the sand and clay were not mixed, but instructions were left with the local officials as to the proper manner of mixing during wet weather.

The total length graded was 4,000 feet for a width of 28 feet in both cuts and fills. The surfaced portion was 4,000 feet in length for a width of 14 feet, making 6,222 square yards surfaced. Two inches of sand were spread over the clay in order to retain the moisture.

The cost of the road to the community was $1,262.60, which is at the rate of $0.203 per square yard. The principal items of cost were as follows: Clearing and grubbing at $0.0077 per square yard, $95.80; shaping subgrade at $0.0096 per square yard, $59.50; plowing clay at $0.017 per cubic yard, $18; loading clay at $0.087 per cubic yard, $119.80; hauling clay at $0.48 per cubic yard, $663; dumping and spreading clay at $0.072 per cubic yard, $99.25; covering clay with sand at $0.007 per square yard, $45.20; preparing pit and roadway for hauling clay, $162.05. Labor cost $1.60 and teams $3 per 8-hour day.

Anderson County, Anderson, S. C.—Work was begun on a sand-clay road extending from Anderson City line westward on September 10, 1913, and completed November 14, 1913, with a loss of 10 days on account of bad weather. The adjacent land is hilly, and the natural soil a clay containing some sand. A total length of 2,300 feet was graded 32 feet wide in both cuts and fills. Earth was excavated to the amount of 2,446 cubic yards, and the average haul was 500 feet, with a maximum haul of 1,300 feet. From station 1+50 to station 4+00 a course of cinders 12 inches deep and 16 feet wide was laid as a foundation. Throughout its entire length the road was surfaced to a width of 16 feet, making 4,089 square yards. Six hundred and eighty-one cubic yards of surfacing material were used.

Cross drains were constructed as follows: From 0+50 to 1+05 a 15-inch clay pipe was laid parallel to the road, and at 21+25 the existing 15-inch clay pipe was extended 17½ feet.

The equipment consisted of a rooter plow, horse roller, grader, and wagon. The total cost of the road was $913, which is $0.1116 per square yard. The principal items of cost were as follows: Excavation at $0.23 per cubic yard, $562.86; shaping at $0.0044 per square yard, $18; labor on culverts, $11.50; end walls, $2.75; loading and hauling sand at $0.2469 per cubic yard, $169.10; spreading sand at $0.0284 per cubic yard, $19.32; rolling at $0.0007 per square yard, $2.75; loading, hauling, and spreading cinders at $0.5908 per cubic yard, $87.43; loading and hauling stone, $4.80; ditching, $14.69; mixing sand and clay, $9.90; general expenses, $6.30; cement, $3.60. The above costs are based upon a labor cost of $1 and a cost for teams of $3 per day of 10 hours.

BEE COUNTY, BEEVILLE, TEX.—Work was begun on an adobe and sand-clay road extending west from Beeville toward Oakville on March 17, 1914, and completed on April 20, 1914, with a loss of one day on account of rain. The surrounding country is rolling and hilly. The nature of the soil is as follows: Station 0+00 to station 4+00, sandy; 4+00 to 6+00, adobe rock; 6+00 to 17+50, sandy loam; 17+50 to 20+00, adobe rock; 20+00 to 22+00, sandy; 22+00 to 27+00, adobe; 27+00 to 40+00, sandy loam underlaid with red sand-clay; 40+00 to 52+80, adobe rock. The road was graded 22 feet wide in cuts and fills for a distance of 5,280 feet. The maximum grade on the old road of 5.5 per cent was reduced to 4.5 per cent. For 4,280 feet the road was surfaced for the full width of 22 feet with either sand-clay or adobe obtained from the right of way, and on two sections totaling 1,000 feet it was surfaced for a width of 15 feet, making a total surfaced area of 12,017 square yards.

One 6 by 2 foot reinforced-concrete slab culvert 20 feet long was built. A 3-inch plain concrete floor was laid between footings to prevent scour. The end and abutment walls were also plain concrete. The total cost of the culvert was $254.53. The principal items of cost are: Excavation and backfill, 20 cubic yards at $0.525 per cubic yard, $10.50; hauling materials an average of 3 miles, $72.60; building forms, $5; mixing and placing 16.4 cubic yards of concrete at $2.48 per cubic yard, $40.75; cutting and placing 320 feet of steel at $0.026 per linear foot, $8.30; cement, 16 barrels at $2.35 per barrel, $37.60; creek sand ready for use, not including hauling, 2 cubic yards at $1.65 per cubic yard, $3.30; gravel ready for use, 12 cubic yards at $1.85 per cubic yard, $22.20; crushed stone, 2 cubic yards at $2.75 per cubic yard, $5.50; lumber for forms, 914 feet b. m. at $0.033 per foot, $29.82; steel reinforcing rods, 523 pounds at $0.035 per pound, $18.31; nails, $0.40; wire, $0.25; making a total of $137.15 for labor and $117.38 for material.

The equipment used was 2 grading plows, 2 rooter plows, 8 No. 2 wheel scrapers, 5 slip scrapers, 1 road machine, 1 road drag, and necessary picks, shovels, etc. The total cost of the work, excluding the concrete culvert, was $1,056.70, or $0.088 per square yard. Labor was $1.50 per day and teams $4.50 per day.

FREESTONE COUNTY, TEAGUE, TEX.—The work of constructing a sand-clay road east from Teague toward Dew was begun on April 2, 1914, and completed April 18, 1914. No time was lost on account of bad weather or other causes. The surrounding country is rolling. The top soil is sand. From 6 to 60 inches below the surface clay is found.

The road was graded 24 feet wide for a distance of 5,330 feet. The maximum grade of 3.3 per cent was changed to 2.9 per cent. The maximum cut was 6 inches and the maximum fill 7 inches. About 3,755 feet of the road had previously been surfaced with clay, and on this portion the work consisted in mixing sand in with the clay surface and reshaping the road. It was necessary to build a complete surface on the remaining 1,575 feet, which was through sand. After this old sand road was shaped up it was surfaced to a width of 15 feet with new clay obtained from the roadside or near-by pits, making an area of 2,625 square yards. This surfacing was broken up and mixed with the sand underneath by the use of a plow and harrow. Water was used to aid in the mixing. The surface was then shaped with a grader, rolled, and dragged. The equipment consisted of three Fresno scrapers, plow, sprinkling wagon, disk harrow, grading machine, drag, and a horse roller.

A 20-inch corrugated-iron culvert, 28 feet long, with concrete end walls, was taken up and relaid at a cost of $20.

The cost of excavation with Fresno scrapers was $89.75; trimming shoulders, ditches, and cleaning out culvert channels, $9.56; dragging, $3.40; shaping with grader, $35.50; general expenses, including foreman, $62.15. The cost of surfacing was: Placing clay on subgrade, $43.87; plowing and harrowing, $103.44; shaping, $14; sprinkling, $24.38; rolling, $23; making a total cost for the work, exclusive of drainage structures, of $415.05, which includes $6 for surveying. Teams were $2.50 per day without drivers, and laborers $1.50 per day of eight hours.

TOPSOIL ROADS.

Apache County, St. Johns, Ariz.—Construction work was begun in Apache County, Ariz., on the Big Hollow Road, which extends west from St. Johns toward Holbrook, on August 28, 1913, and completed January 15, 1914. Two days were lost on account of bad weather. The grading work was suspended from October 8, 1913, to January 7, 1914, while the culverts and bridges were being built. The surrounding country is very hilly. From station 6+00 to 53+00 the soil is an adobe, very muddy and sticky in wet weather; from station 53+00 to 61+15 the soil is gravelly, providing a fair natural road surface.

The road was graded for a length of 5,515 feet, 20 feet wide in cuts and 16 feet wide in fills, a total of 9,210 square yards. The volume of earth moved was 6,280 cubic yards. The maximum cut was 3.2 feet and the maximum fill was 4.4 feet. The maximum grade was reduced from 10.7 per cent to 6.5 per cent. The earth was taken from borrow ditches along the side of the road with plows, Fresnos, slips, and grader.

The road was surfaced from station 7+00 to station 53+00. From stations 7 to 33 a subgrade was prepared, and the material, a natural sand-clay mixture, combined with a small amount of soft limestone, was spread to a depth of 8 inches. From stations 33 to 53 the material, which is similar to a loam, was spread to a depth of 10 inches at the center and tapered to zero at the edges. The width of surfacing material throughout was 8 feet and the crown three-fourths inch to the foot. The total area surfaced was 4,090 square yards. There were 495 cubic yards of gravel hauled an average of three-fourths mile, and the remaining 385 cubic yards were hauled an average of one-fourth mile. The gravel was loosened with a rooter plow and loaded by hand into 1-yard dump wagons. It was dumped from these wagons onto the subgrade and spread with a hoe.

Four drainage structures were built. At station 34+50 a 60-inch corrugated iron culvert was placed, 24 feet long, with concrete end walls and wings. The 60-inch corrugated pipe cost $6.15 per linear foot delivered at St. Johns, and the 48.5 cubic yards of concrete cost $14.78 per cubic yard. The total cost of the structure was $864.40.

At station 40+50 a semicircular corrugated-iron arch bridge, 14-foot span, with concrete abutments, parapets, and wings, was erected. The cost of concrete work was $15.45 per cubic yard for 132 cubic yards, and the reinforcement cost $34, making the total cost, exclusive of the 14-foot semicircular section of corrugated iron, $2,073.40.

At station 45+50 a concrete arch bridge was built of three 14-foot spans of semicircular corrugated-iron sections, with concrete abutments, piers, parapets, etc. The cost for the concrete work was $19.13 per cubic yard for the 195 cubic yards. The reinforcement cost $42.50, and the removal of an old standing wall was $50, making the total cost for the structure, excluding the cost of the three 14-foot span corrugated-iron sections, amount to $3,822.85.

At station 51+00 a 30-inch corrugated-iron culvert was built, 20 feet long, with concrete end walls. The cost of the 30-inch pipe delivered at St. Johns was $2.94 per linear foot. The cost of the concrete was $33.61 per cubic yard for the 4.5 cubic yards, making a total cost for the culvert of $210.05.

The total cost for culverts and bridges was $6,970.70. Cement was $1.54 per bag delivered at St. Johns. The contract price for excavation was $0.25 per cubic yard for 6,280 cubic yards, or $1,570, and for surfacing it was $1.10 per cubic yard for 880 cubic yards, or $968, which is $0.237 per square yard. The total cost of the road, including excavation, surfacing, and drainage structures, was $9,508.70, or $9,102.72 per mile.

Gates County, Sunbury, N. C. (Section 1).—Two sections of object-lesson road were constructed at Sunbury during the fiscal year, and will be described separately. Work was started on the first section, extending from Sunbury northward toward Suffolk, on October 29, 1913, and completed December 2, 1913, with a loss of two days on account of bad weather. The adjacent land is level and the natural soil is a sandy loam from the beginning to station 5+75; clay from 5+75 to 15+00; sandy loam from 15+00 to 20+00. A total length of 2,300 feet was graded 30 feet wide in cuts and 25 feet wide in fills. Earth was excavated to the amount of 450 cubic yards, and the average haul was 150 feet, with a maximum haul of 200 feet.

The road was surfaced for 850 feet to a width of 15 feet, making 1,416 square yards. A topsoil type of construction was used, and the surfacing material was hauled an average distance of 1,700 feet from a pit and spread in one course to a depth varying from 10 to 12 inches before compacting. Approximately 300 cubic yards of topsoil were placed, after which the entire width of the road was harrowed, dragged, and finished with a crown of three-fourths inch to the foot. The binding qualities of the material are good, but the wearing qualities are only fair.

Cross drains of wood were built at stations 5+75 and 10+00.

The equipment consisted of a disk harrow, tooth harrow, plank drag, steel drag, drag scraper, two road graders, two plows, and a few carts. The total cost of the road was $382.09, and the principal items of cost were as follows: Clearing and grubbing, $35.18; rough grading, 6,930 square yards at $0.0092 per square yard, $63.99; fine grading, 6,930 square yards at $0.00087 per square yard, $6.04; culvert excavation, 10 cubic yards at $0.495 per cubic yard, $4.95; cutting poles for culverts, 10 poles at $0.06 per pole, $0.60; building wooden culvert, $1.35; loosening and loading top soil, 300 cubic yards at $0.0491 per cubic yard, $14.75; hauling top soil, 300 cubic yards at $0.2047 per cubic yard, $61.42; spreading top soil, 300 cubic yards at $0.0172 per cubic yard, $5.16; excavating and spreading clay, 450 cubic yards at $0.2056 per cubic yard, $92.55; mixing topsoil, 2,390 square yards at $0.00202 per square yard, $4.83; compacting with tooth harrow, 4,400 square yards at $0.0006 per square yard, $2.64; trimming shoulders and ditches, $3.52; general expenses, $46.09; hauling culvert material, $2.68; topsoil purchased, $20; explosives, $5.63; other materials, $10.71. The above costs were based upon a labor cost of $1.35, and a cost for mules of $1 per day of nine hours.

Gates County, Sunbury, N. C. (Section 2).—Work was begun on the second section, extending from Sunbury southward toward Milldam, on December 2, 1913, and continued to January 14, 1914, with a loss of one day on account of bad weather and a loss of 12 days due to other causes. The adjacent land is level, and the natural soil is a clay from station 0+00 to 1+70; sandy soil from 1+70 to 3; clay from 3 to 8; sandy soil from 8 to 17+50. A total length of 1,750 feet was graded 30 and 40 feet wide in cuts and 25 feet wide in fills. Earth was excavated to the amount of 550 cubic yards, 300 cubic yards of which were excavated from ditches and used on the road. Approximately 2,468 square yards of road were surfaced with 436 cubic yards of topsoil.

At station 15 a 16-inch corrugated metal culvert 38 feet long was placed and at station 15+75 a blind drain 20 feet long was constructed.

The total cost of the road was $354.19, which is at the rate of $0.144 per square yard, exclusive of drainage structures. The principal items of cost were as follows: *Grading:* Clearing and grubbing, $24.89; plowing $6.98; work done with drag scrapers, $21.16; dump carts, $23.55; handwork, $3.30; grader work, $4.23; digging ditches, $66.20; trimming shoulders, $28.77; superintendence, $32. *Surfacing:* Preparing subgrade, $13.56; stripping, $3.82; loading and hauling, $60.94; spreading, $8.45; mixing, $1.67; shaping, $3.76; compacting, $3.17; superintendence, $13.50; surfacing materials, $16.60; general expenses, $12.05. *Drainage structures:* Excavation, $1.20; hauling, $1.97; building wall, $1.20; placing pipe, $1.17. The above costs were based on labor at $1.25 and $1.50, and teams including driver at $3, per day of 10 hours.

Davidson County, Thomasville, N. C.—Work was begun on a topsoil road leading from Thomasville toward Randolph County on July 31, 1913, and completed on September 20, 1913, with a loss of eight days on account of bad weather. The adjacent land is rolling, and the natural soil is a yellow clay from station 0 to 20, except for rock ledges between station 4+00 and 4+50; station 10+50 and 11+25; station 14+75 and 15+25. From station 20 to 23 is gray topsoil, and from station 23 to 25 is a red clay. Scarcity of sand was the reason for using topsoil in the road surface instead of following the regular method of sand-clay construction. A total length of 3,500 feet was graded 30 feet wide in cuts and 25 feet wide in fills.

Earth was excavated to the amount of 3,359 cubic yards, and the rock excavation amounted to 311 cubic yards. The average haul for all excavation was 375 feet, and the maximum haul 725 feet. The road was surfaced with topsoil 15 feet wide for a distance of 1,200 feet, making 2,000 square yards. This required 444 cubic yards of material, which was hauled an average distance of 1,000 feet. The topsoil was spread by hand and with a grader.

Two concrete culverts were replaced and one new concrete culvert was constructed, all of which were provided with stone head walls.

The equipment consisted of 1 road grader, 4 wheeled scrapers, 8 pan scrapers, and 2 road plows. The total cost of the road was $1,199.19, including culverts, which is at the rate of $0.60 per square yard. The principal items of cost were as follows: Excavation at $0.24 per cubic yard, $882.49; shaping at $0.0444 per square yard, $185.25; culvert pipe at $0.75 per linear foot, $22.50; labor on same, $7.75; loading topsoil at $0.1568 per cubic yard, $18.50; hauling same to road at $0.1525 per cubic yard, $18; spreading topsoil at $0.0318 per cubic yard, $3.75; trimming shoulders, $8.25; shaping topsoil, $4.50; explosives, $32.20; general expenses, $16. Labor was paid $1.25 and teams $3 for 10-hour day.

APPOMATTOX COUNTY, APPOMATTOX, VA.—The construction work was begun on the Oakville road extending northwest from Appomattox toward Oakville on May 15, 1913, and supervision by the office representative ended May 14, 1914. During that period 36 days were lost on account of bad weather and 3 days from other causes. The surrounding country is hilly. The character of the soil from station 0 to 116 and from 162 to 178 was Cecil red clay, and from station 116 to 140 and from 145 to 162 was Iredell clay loam.

The road was graded to a width of 28 feet in cuts and 20 feet in fills for a distance of 18,100 feet. The volume of earth excavation was 24,000 cubic yards and of rock 290 cubic yards. The maximum cut was 7.3 feet and the maximum fill 14.7 feet. The maximum grade was reduced from 15 to 5 per cent. The surfacing was a gray topsoil, found in layers of from 4 inches to 8 inches in near-by blackjack oak woods. It was hauled in slat-bottom wagons an average distance of 4,700 feet and spread with rakes to a width of 16 feet and a compacted depth of 10 inches for a distance of 12,700 feet, or an area of 22,600 square yards.

It was found necessary to use a 4½-inch foundation of broken field stone in two level bottoms, totaling 3,900 feet in length.

Sixteen corrugated-iron culverts, totaling 574 linear feet, and three vitrified-clay pipe culverts, totaling 136 linear feet, were built. The sizes varied from 12 to 36 inches. Head walls are of field stone laid in cement mortar.

The equipment used consisted of plows, slip scrapers, wheelbarrows, picks, shovels, and rakes.

The work was done with a State convict gang averaging 32 men. They were furnished free to the county. The county provided foremen and all necessary equipment and running expenses. The convict labor was rated at $1 per day and teams $3 per day, including convict drivers. The total cost of the work was $14,736.92, of which the county paid 45 per cent and the State furnished 55 per cent in convict labor. The principal items of cost were: Clearing and grubbing 4.6 acres at $93.90 per acre; moving 1,800 feet of fence at $0.028 per foot; moving 24 telephone poles at $2.94 each; excavation of earth, 24,000 cubic yards at $0.239 per cubic yard, and of rock, 290 cubic yards at $0.629 per cubic yard; excavation and placing culverts, 710 feet at $0.18 per foot; preparing subgrade for rock, 38,700 square yards at $0.0127 per square yard; loosening and loading soil, 4,900 cubic yards at $0.256 per cubic yard; hauling 4,900 cubic yards of soil an average distance of 4,700 feet at $0.50 per cubic yard mile; spreading 4,900 cubic yards of soil at $0.061 per cubic yard; excavation and spreading soil from side of road, 500 cubic yards at $0.252 per cubic yard; loading 1,100 cubic yards of foundation stone at $0.213 per cubic yard, and hauling the same an average of 6,800 feet at $0.378 per cubic yard mile; spreading and breaking 1,100 cubic yards of foundation stone at $0.329 per cubic yard; trimming 9,800 feet of shoulders and ditches at $0.015 per foot; maintaining 2 miles of soil road for three months at $15.91 per mile; culvert pipe, $830.06; engineering and traffic census, $149.30; and superintendence, 11.1 per cent, or $1,472.24.

EARTH ROADS.

TODD COUNTY, ELKTON, KY.—Work was begun on an earth road north from Elkton toward Claymour on October 16, 1914, and completed to station 19 on December 5, 1914, with a loss of 11 days on account of rain and other causes. The adjacent land is hilly and the natural soil is clay with a large percentage of sand. The road was graded 26 feet wide in cuts and 20 feet wide in fills for 1,900 feet. The maximum cut was 2.7 feet, the maximum fill 3.5 feet, and the total amount of excavation 1,693 cubic yards. The maximum grade of 3.69 per cent was reduced to 3.52 per cent. The grubbing and clearing was so heavy the grading could not be economically done with blade graders. Earth was loosened with plow, moved by drag and wheeled scrapers, and spread by drags and by hand. No rolling was done.

Drainage structures were constructed as follows: At 4+60 a 20-inch corrugated-iron pipe, 24 feet long, costing $28.87; at 7+24 a 24-inch corrugated-iron pipe, 24 feet long, costing $35.88; at 13+21 a reinforced-concrete box culvert, 4 by 2.5 feet and 21 feet 8 inches long, containing 9.21 cubic yards, costing $107.86, or 11.71 per cubic yard. No head walls on pipe culverts.

The equipment consisted of a road plow, drag scrapers, and four-wheeled scrapers. Labor cost $1.25 per day, foreman $2 per day, and man and team $3 per day of 10 hours. The total cost of the road, exclusive of drainage structures, was $559.92, which is at the rate of $0.1225 per square yard. The principal items of cost were: Clearing and grubbing, $102.56; excavation, at $0.232 per cubic yard; shaping, $0.00072 per square yard; and superintendence, $61.30.

CHICKASAW COUNTY, WOODLAND, MISS.—Work was begun on the Pontitock Ridge road leading from Woodland toward Pontitock Ridge on July 9, 1913, but the representative from this office remained until July 18, 1913, just long enough to get the work well under way. The road was graded 1,200 feet in length for a width of 24 feet at the time of his departure. The adjacent land is rolling and the natural soil is clay. The road was built by subscription and donated labor and teams, and the estimated cost is based on $1 per 10 hours for labor and $3 per 10 hours for teams. On the above basis the cost to the community was $72.66, or at the rate of $0.022 per square yard.

OKMULGEE COUNTY, OKMULGEE, OKLA.—A stretch 4,820 feet long and 20 feet wide on the road leading south from Okmulgee toward Henryetta was graded in August, 1913. The area graded was 10,711 square yards. The volume of earthwork was 3,497 cubic yards and the cost $1,365, or $0.127 per square yard, or $0.390 per cubic yard.

Five culverts were built of good hard sandstone: One 2 by 2 by 20 feet, rubble masonry, with stone slab top; two 2 by 4 by 20 feet, rubble masonry, with reinforced concrete slab; one 3 by 4 by 20 feet, rubble masonry, with reinforced concrete slab; one 3 by 5 by 20 feet, rubble masonry, with reinforced concrete slab. Two existing rubble culverts were repaired, one of which was lengthened to 20 feet. The culvert work aggregated 69.36 cubic yards and was performed under a verbal contract for $350, or $5.05 per cubic yard.

See Okmulgee, Okla., under "sand-clay road," for further information of work done on an adjoining section of road at this place.

GIBSON COUNTY, CADES, TENN.—Work was begun on an earth road extending west from Cades toward Trenton on August 3, 1914, and completed August 21, 1914. The adjacent land is quite hilly and the soil is clay with considerable sand. This road was graded with plow, scrapers, and grader to a width of 26 feet in cuts and 20 feet in fills for a length of 4,200 feet. The maximum cut was 2.5 feet and the maximum fill 2 feet. The maximum grade of 4 per cent was not changed.

The total cost of the work was $664.79, or $0.0656 per square yard. The principal items of cost were: Clearing and grubbing 2,444 square yards at $0.0089 per square yard, $21.87; excavation and embankment at $0.059 per square yard, $594.80; trimming slopes and ditches, $6.87; and superintendence, $41.25.

Gibson County, Milan, Tenn.—Work was begun on an earth road extending north from Milan toward Cades on June 15, 1914, and completed August 18, 1914, with a loss of one day on account of bad weather and one day due to a public holiday. The adjacent land is rolling and the soil consists of clay with considerable sand. The road was graded with plow, scrapers, and grader to a width of 36 feet in cuts and 32 feet in fills for a distance of 17,600 feet. The maximum cut was 3.7 feet and the maximum fill 2.5 feet. The maximum grade of 5 per cent was not changed. Considerable grubbing was necessary.

The total cost of the work was $1,570.55, or $0.024 per square yard. The principal items of cost were: Clearing and grubbing 5,555 square yards at $0.0175 per square yard, $97.19; excavation and embankment at $0.020 per square yard, $1,319.11; trimming slopes and ditches, $8.75; and superintendence, $145.50. Labor was $1.25 and teams $3 per day of 10 hours.

Erath County, Dublin, Tex.—Work was begun on a gravel-macadam road extending north from Dublin toward Stephenville on October 29, 1913, and continued until December 21, 1913, with a loss of 26 days on account of bad weather. All work was stopped on December 21, 1913, on account of a continuous season of heavy rain. The nature of the soil and the excessive rains (2.61 inches in 5 days) made work impossible. The adjacent land is rolling with low hills, and the natural soil is black, sticky clay throughout. The road was graded 30 feet wide in cuts and 21 to 24 feet in fills for a total distance of 2,600 feet; of this distance only 4,000 square yards were completely graded. The maximum cut was 1.5 feet, the maximum fill 3.8 feet, and the maximum grade on the old road of 3 per cent was reduced to 1½ per cent on the new road.

At station 2+11 a culvert of two 30-inch corrugated-iron pipes 24 feet long was built with stone masonry end walls, at a total cost for labor and material of $180.40. At station 25+90 masonry abutments were built for a 16-foot span bridge at a total cost of $250.69.

In clearing, grubbing, excavation, and embankments, and fine grading, $403.67 was expended, and on various work in preparation for surfacing with gravel, $79.39. Free labor cost $1.25 per day of eight hours, hired teams, $2.50 per day, and county teams $2.40 per day.

SUPERINTENDENCE OF COUNTY ROADS.

Calcasieu Parish, La.

BRICK, GRAVEL, AND EARTH ROADS.

A model highway system was reported upon in October, 1913, involving the improvement of 142 miles of road, and a bond issue amounting to $900,000 was raised to complete the work. A department was organized by a representative of the Office of Public Roads to make surveys, prepare plans, etc., and to supervise the work of construction. On January 1, 1915, about 80 miles of road had been contracted for and nearly 60 miles completed. The contracts let also include 24 reinforced concrete culverts, 41 reinforced concrete bridges, 2 steel swing-bridges, 1 combination bridge, 14 timber culverts, 17 timber bridges, 1,540 linear feet of 12-inch concrete or tile-pipe culverts, 2,603 linear feet of 18-inch concrete or tile-pipe culverts. The material for the bridges and culverts includes 2,547 cubic yards of concrete, 185,917 pounds of reinforcing steel, and 163,000 feet b. m. of timber. The work was planned in 16 divisions, which are referred to herein as highways Nos. 1, 2, 3, etc. The total aggregate of the contracts let amounts to $597,458.79. Highways Nos. 5, 6, 7, 8, 14, and 16, totaling 62 miles, still remain to be contracted for under the $900,000 bond issue. The work done has proved so successful that steps have been taken to raise $300,000 additional for the construction of a bridge over the Calcasieu River, and to extend the highway system now being constructed.

Considerable work was done by convicts in the manufacture of concrete pipe and concrete piles. The following were the unit costs for this work:

12-inch concrete pipe at 12 cents per foot;
18-inch concrete pipe at 18 cents per foot;
15-foot concrete piles at $11.60 each;
25-foot concrete piles at $14.80 each.

A list and description of the roads on which contracts have been awarded to date follows:

Highway No. 1 consists of 9 miles of 15-foot gravel road, 6 inches thick, with earth shoulders; and 5½ miles of 9-foot brick road on a 5-inch gravel base, part with earth shoulders and part with 6-inch gravel shoulders. The shoulders are 3 feet wide. All bridges and culverts are of reinforced concrete, and the pipe culverts are provided with concrete head walls. The following unit prices obtained:

Clearing and grubbing, complete	$300.00
Excavation, per cubic yard	.195
Embankment, per cubic yard	.22
Vitrified pipe, 12-inch, per foot, complete	.70
Vitrified pipe, 18-inch, per foot, complete	1.00
Concrete pipe, 12-inch, per foot, hauling and placing only	.40
Concrete pipe, 18-inch, per foot, hauling and placing only	.50
Gravel road, per square yard	.30
Vertical fiber brick on gravel base, per square yard	1.85
Concrete piles, hauling and driving, per linear foot	1.00
Concrete, 1 : 2 : 4, per cubic yard	9.00
Concrete, 1 : 3 : 6, per cubic yard	7.50
Reinforcing steel, per pound	.03

Highway No. 2 consists of 12 miles of brick road 9 feet wide, on a 5-inch gravel base; 9 miles of 15-foot gravel road, 6 inches thick; and considerable bridge work. This work was let in three contracts.

Contract No. 1, for sections 1 and 3, was let at the following unit prices:

Clearing and grubbing, complete	$225.00
Excavation, per cubic yard	.24
Embankment, per cubic yard	.24
Vitrified pipe, 12-inch, per foot, complete	.60
Vitrified pipe, 18-inch, per foot, complete	.95
Concrete pipe, 12-inch, per foot, hauling and placing only	.40
Concrete pipe, 18-inch, per foot, hauling and placing only	.50
Gravel road, per square yard	.25
Vertical fiber brick on gravel base, per square yard	1.67

Contract No. 2, for bridges and culverts on sections 1 and 3, was let at the following unit prices:

Concrete, 1 : 2 : 4, per cubic yard	$8.10
Concrete, 1 : 3 : 6, per cubic yard	7.10
Reinforcing steel, per pound	.0575

Contract No. 3, for section 2, was let at the following unit prices:

Clearing, per acre	$7.50
Grubbing, per station	6.00
Excavation, per cubic yard	.20
Embankment, per cubic yard	.22
Vitrified pipe, 12-inch, per foot, complete	.60
Vitrified pipe, 18-inch, per foot, complete	.90
Concrete, 1 : 2 : 4, per cubic yard	12.00
Reinforcing steel, per pound	.04
Gravel road, per square yard	.23

Highway No. 3 is an 18-foot earth road 13 miles long; also 1,300 feet of timber trestle. Contract was let at the following unit prices:

Clearing, per acre	$75.00
Grubbing, per station	5.00
Excavation, per cubic yard	.26
Embankment, per cubic yard	.26
Vitrified pipe, 12-inch, per foot, complete	.71
Vitrified pipe, 18-inch, per foot, complete	1.16
Concrete pipe, 12-inch, per foot, hauling and placing only	.35
Concrete pipe, 18-inch, per foot, hauling and placing only	.65
Wood pile driven below cut-off, per foot	.70
Wood pile driven above cut-off, per foot	.55
Concrete, 1 : 2 : 4, per cubic yard	13.00
Reinforcing steel, per pound	.05
Timber, per thousand feet board measure	40.00
Iron in structures, per pound	.05

Highways Nos. 4 and 10 consist of 2½ miles of 15-foot gravel road 6 inches thick; 7½ miles of 18-foot, surfaced with 9 feet of gravel 6 inches thick, with a maximum haul of 9 miles; and 6 miles of 18-foot road with 9-foot shell, 6 inches thick in the center. The bridges and culverts on this road are all concrete. The following unit prices obtained:

Clearing and grubbing, complete	$50.00
Excavation, per cubic yard	.22
Embankment, per cubic yard	.35
Vitrified pipe, 12-inch, per foot, complete	.75
Vitrified pipe, 18-inch, per foot, complete	.95
Concrete pipe, 12-inch, per foot, hauling and placing only	.40
Concrete pipe, 18-inch, per foot, hauling and placing only	.50
Concrete piles, hauling and driving, per linear foot	.85
Concrete, 1 : 2 : 4, per cubic yard	13.00
Concrete, 1 : 3 : 6, per cubic yard	12.00
Reinforcing steel, per pound	.0225
Gravel road, per square yard	.44
Shell road, per square yard	.40

Two bridges for the Intercoastal Canal, for highways Nos. 6 and 8, respectively, were contracted for at the following unit prices:

Wood pile driven below cut-off, per foot	$0.80
Wood pile driven above cut-off, per foot	.80
Concrete, 1 : 2 : 4, per cubic yard	13.85
Concrete, 1 : 3 : 6, per cubic yard	13.10
Supply and erection of steel work and turning machinery and the construction of two bridges	6,580.00

Highway No. 9 consists of 10 miles of earth road with timber bridges. Concrete pipe culverts were used. Drainage was difficult, as the road runs through low marshes and swamps. The following unit prices obtained:

Clearing, per acre	$75.00
Grubbing, per station	5.00
Excavation, per cubic yard, complete	.28
Embankment, per cubic yard, complete	.28
Vitrified pipe, 12-inch, per foot	.71
Vitrified pipe, 18-inch, per foot	1.16
Concrete pipe, 12-inch, per foot, hauling and placing only	.35
Concrete pipe, 18-inch, per foot, hauling and placing only	.65
Wood pile driven below cut-off, per foot	.70
Wood pile driven above cut-off, per foot	.55
Concrete, 1:2:4, per cubic yard	13.00
Reinforcing steel, per pound	.05
Timber, per thousand feet board measure	40.00
Iron in structures, per pound	.05

Highways Nos. 12 and 13 consist of 4 miles of earth road and 1½ miles of gravel road 15 feet wide and 6 inches thick. The following unit prices obtained:

	No. 12.	No. 13.
Clearing and grubbing, complete	$560.00	$360.00
Excavation, per cubic yard	.22	.22
Vitrified pipe, 12-inch, per foot, complete	.70	.75
Vitrified pipe, 18-inch, per foot, complete	1.00	1.00
Concrete pipe, 12-inch, per foot, hauling and placing only	.55	.55
Concrete pipe, 18-inch, per foot, hauling and placing only	.75	.75
Concrete, 1:2:4, per cubic yard	11.00	11.50
Reinforcing steel, per pound	.04	.04
Gravel road, per square yard		.25

BENNINGTON COUNTY, VT.

BITUMINOUS CONCRETE.

BENNINGTON, VT.—Work was begun on a bituminous concrete road extending east from Opera Hall toward Woodford on the main street on August 18, 1913, and completed on September 1, 1913. One day was lost on account of bad weather. The adjacent land is level.

The surfacing was placed on an old macadam road, which was torn up, reshaped, and rolled. The average haul from the siding to the road was 1 mile. The bituminous concrete was spread cold by stone hooks and rakes over an area of 4,851 square yards. This was laid in two courses, respectively 3½ inches and one-half inch in depth.

The total cost of the work was $3,786.90, which is at the rate of $0.78 per square yard.

MACADAM WITH BITUMINOUS SURFACE TREATMENT.

BENNINGTON, VT.—Work was begun on bituminous surface treatment of macadam road extending south from Bennington Center toward Pownal, on the Everett Road, on May 5, 1913, and completed on September 20, 1913, with a loss of 45 days from various causes. The adjacent land is hilly and the natural soil is clay with one section of ledge.

The road was graded 19 feet wide in both cuts and fills for a distance of 1,980 feet through the entire length for a width of 14 feet, or an area of 3,080 square yards. This was surfaced as follows: Eight inches of crusher-run field stone was laid in one course and rolled. Owing to a deficiency of binder in the crusher-run stone, sand was added; this was coated by hand sprinkler with about one-third gallon to the square yard of bituminous material and again covered with sand.

One 4 by 3 foot stone culvert 22 feet long was laid.

The funds were raised one-half by private subscription and one-half by the State. The total cost of the work was $2,551.45, or $0.829 per square yard.

MACADAM ROAD.

ARLINGTON, VT.—Work was begun on a macadam road extending west from East Arlington toward the Arlington Depot on the East Road on August 4, 1913, and completed on October 29, 1913. Fifteen days were lost from various causes. The adjacent land is swampy on the south and hilly on the north, with a natural soil of clay and loam.

The road was graded 22 feet wide in both cuts and fills for a distance of 2,004 feet. The maximum cut was 0.75 foot, the maximum fill 2 feet, and the maximum grade on the old road of 4 per cent was reduced to 3 per cent on the new road. A macadam surface 18 feet wide, making an area of 4,008 square yards, was laid with a first course of 9 inches of crushed local stone and a depth of 3 inches loose gravel surface. No roller was used.

One thousand six hundred feet of side drain, an equal amount on either side, was constructed, using screened gravel and tailings from the crusher.

The total cost of the work was $2,603.01, or $0.650 per square yard.

STAMFORD, VT.—Work was begun on a macadam section of the Village Road extending east from Stamford toward Readsboro on June 9, 1913, and completed on October 25, 1913, with 72 days' loss of time from various causes. The adjacent land is hilly and the natural soil sandy. The road was graded 21 feet wide in both cuts and fills for 1,500 feet. The maximum cut was 1 foot and the maximum fill 2 feet. The maximum grade of 3 per cent was reduced to 2 per cent.

A surface of unrolled macadam was laid for 1,500 feet, 14 feet wide, making 2,333 square yards. Crushed field stone was used as a surfacing material, and this was laid loose 6 inches thick and then covered with a coating of pit gravel. Three 12-inch and one 14-inch metal pipe culverts were placed at a cost of $113.94.

The total cost of the road, exclusive of drainage structures, was $801.98, which is at the rate of $0.344 per square yard, or $2,822.97 per mile.

GRAVEL ROADS.

ARLINGTON, VT. (No. 1).—Work was begun on a gravel road extending south from Arlington toward Shaftsbury on the south road on July 7, 1913, and completed on September 20, 1913, with 24 days lost from various causes. The adjacent land is swampy on the east, mountainous on the west, and the natural soil is sandy and saturated by underground springs feeding into the lowlands. This ground is unstable and subject to frost action.

The road was graded 21 feet wide in both cuts and fills for a distance of 4,150 feet. This was then surfaced 16 feet wide, making an area of 7,378 square yards, with 8 inches of gravel of good quality hauled 1,000 feet.

The total cost of the work was $728.71, or $0.099 per square yard. The principal items of cost were: Excavation, 1,000 cubic yards of earth and 10 yards of rock, $307.90; surfacing, $385.98; miscellaneous, $34.83.

ARLINGTON, VT. (No. 2).—Work was begun on a gravel road extending north from West Arlington toward Sandgate on September 24, 1913, and completed on November 1, 1913, with 10 days lost from various causes. The adjacent land is swampy on the east, mountainous on the west, and the natural soil is saturated clay with some disintegrated rock.

The road was graded 18 feet wide in both cuts and fills for a distance of 1,039 feet. This was surfaced 14 feet wide for a distance of 742 feet, making an area of 1,154 square yards. The gravel, which was laid 8 inches in depth, was hauled 1,000 feet.

One 18-inch concrete pipe culvert was laid and one 3 by 4 foot stone culvert extended.

The total cost of the work was $410.77.

ARLINGTON, VT. (No. 3).—Work was begun on a gravel section extending west from West Village toward New York on the west road on November 1, 1913, and completed on November 26, 1913. Nine days were lost from various causes. The adjacent land is swampy on the south, mountainous on the north, and the natural soil is clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 495 feet. A width of 20 feet, or a total area of 1,100 square yards, was surfaced with 8 inches of gravel, hauled 1,000 feet.

One 1½ by 1½ foot culvert 24 feet long was rebuilt.

The total cost of the work was $289.31, or $0.263 per square yard.

ARLINGTON, VT. (No. 4).—Work was begun on a gravel road extending north from Arlington toward Sunderland on October 30, 1913, and completed on November 12, 1913, with a loss of five days for various causes. The adjacent land is low and the natural soil is loam.

The road was graded 26 feet wide in fills for a distance of 495 feet, with a maximum fill of 3 feet. This was surfaced 22 feet wide the whole length, making an area of 1,210 square yards. The gravel was hauled an average distance of 400 feet and laid to a depth of 8 inches. The bowlders and cobblestones from the pit were used for foundation.

The total cost of the work was $201.95, or $0.167 per square yard.

BENNINGTON, VT. (No. 1).—Work was begun on a gravel section extending north from Bennington Village toward North Bennington on the Robinson Road on April 28, 1913, and completed November 29, 1913, with 118 days lost from various causes. The adjacent land is low and level and the natural soil is clay and loam.

The road was graded 22 feet wide in both cuts and fills for a distance of 1,318 feet. The entire length for a width of 14 feet, or an area of 2,050 square yards, was surfaced with pit gravel 8 inches thick, hauled 1½ miles. This work was entirely in fill with a maximum of 2.5 feet, and most of the material was taken from a choked channel. Bowlders and cobbles were used for a foundation. The material was all hauled in slat-bottom wagons.

One 16-inch metal culvert was built, at a cost of $24.

The total cost of the work was $2,648.17, or $1.29 per square yard.

Bennington, Vt. (No. 2).—Work was begun on a gravel section extending north from Bennington toward Shaftsbury on the Harwood Hill Road on September 16, 1912, and completed on October 1, 1913, with a loss of 40 days because of bad weather. In addition work was shut down for the winter, from December 14, 1912, to April 10, 1913. The adjacent land is hilly and the natural soil is clay and rock.

The road was graded 22 feet wide in both cuts and fills for a distance of 3,680 feet. The maximum cut was 6 feet, the maximum fill 6 feet, and the maximum grade of 15 per cent was reduced to a maximum of 8 per cent. This work was done by contract under specifications prepared by the Office of Public Roads and approved by the State highway department. The road was surfaced 8 inches deep and 14 feet wide throughout its entire length, making an area of 5,724 square yards. The gravel was hauled 2 miles. A horse roller was used for the gravel surface.

Four 12-inch metal pipe culverts 30 feet long, with concrete head walls, and one 3 by 3 foot concrete culvert were built; and 566 feet of standard Massachusetts V-drain, 758 feet of 6-inch standard side drain, and one catch basin were constructed.

The total cost of the work was $8,948, or $1.561 per square yard. The main items of expense were: 2,530 cubic yards of earth excavation at $0.50 per cubic yard, $1,265; 1,783 cubic yards of rock excavation at $3 per cubic yard, $5,349; surfacing at $0.244 per square yard, $1,394.50; V-drain at $0.50 per foot, $283; side drain at $0.40 per foot, $303.20; 12-inch culvert pipe at $1.20 per foot, $144; concrete work, $145; and miscellaneous work, $64.30.

Bennington Center, Vt.—Work was begun on a gravel section extending west toward Bennington Center on the west main road September 2, 1913, and completed November 1, 1913. Twelve days were lost on account of bad weather. The adjacent land is hilly, and the natural soil is saturated clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,300 feet. An area of 2,600 square yards, or the entire length 18 feet wide, was surfaced with pit gravel 8 inches deep, hauled 2 miles. The maximum cut was 1 foot, the maximum fill 1.5 feet, and the maximum grade of 13 per cent was reduced to 9 per cent.

The drainage structures were: Five 6-inch cross drains and one 18-inch metal pipe culvert; seven brick catch basins; and 1,472 feet of standard Massachusetts 6-inch tile side drain covered with crushed stone 3 inches in size.

The work was done by contract. The principal items of cost were: Earth excavation, $141; shaping subgrade, $93; culvert pipe and labor, $100; side drains and labor, $883.20; surfacing, $450.75; rock excavation, $6; catch basins, $217.31; making a total cost of $1,891.26, or $0.729 per square yard.

Dorset, Vt. (No. 1).—Work was begun on a gravel road extending north from Dorset toward Rupert on the west road on June 25, 1913, and completed on August 30, 1913. Twenty-eight days were lost from various causes. The adjacent land is hilly, and the natural soil gravel and sand.

The road was graded 18 feet wide in both cuts and fills for 1,452 feet. The surface, 16 feet wide, making an area of 2,581 square yards, was laid 8 inches thick with gravel from alongside the road. The maximum cut was 4 feet, the maximum fill 4 feet, and the maximum grade of 12 per cent was reduced to a maximum of 6 per cent.

The total cost of the work was $286.79, or $0.111 per square yard.

Dorset, Vt. (No. 2).—Work was begun on a gravel road extending north from North Dorset toward Mount Tabor on September 15, 1913, and completed on November 1, 1913. Ten days were lost on account of bad weather. The adjacent land is hilly, and the natural soil is sandy.

The road was graded 21 feet wide in both cuts and fills for a distance of 1,200 feet. The gravel was hauled from a point a half mile distant and placed to a depth of 8 inches and a width of 14 feet, making a surfaced area of 1,867 square yards. The maximum cut was 8 feet, the maximum fill 3 feet, and the maximum grade of 7 per cent on the old road was reduced to 4 per cent on the new road.

Three 12-inch metal culverts were built with concrete head walls.

The total cost of the work, including culverts, was $754.41, or $0.404 per square yard.

Dorset, Vt. (No. 3).—Work was begun on a gravel section extending north from East Dorset toward North Dorset, on Hairpin Curve Road, on July 28, 1913, and completed on September 13, 1913, with four days lost on account of bad weather. The road, as relocated, eliminates the Hairpin Curve. The adjacent land is hilly and the natural soil is gravel and bowlders.

The road was graded 21 feet wide in both cuts and fills for a distance of 1,033 feet. This was surfaced the whole length and width, or 2,410 square yards, with gravel obtained from alongside the road and placed to a depth of 8 inches. The maximum cut was 17 feet, the maximum fill 22 feet, and the maximum grade of 10 per cent was reduced to 5 per cent. Work was done with road graders, harrow, New York hone, and split-log drag. A crib of large trees and stumps was built at one point to prevent sliding of the embankment, and a guard rail was also built.

The total cost of the work was $713.70, or $0.296 per square yard.

Dorset, Vt. (No. 4).—Work was begun on a gravel road extending south from East Dorset toward Manchester on the Cemetery Road June 17, 1913, and completed July 12, 1913, with a loss of two days because of bad weather. The adjacent land is rolling and the natural soil is gravel and loam.

The road was graded 21 feet wide in both cuts and fills for a distance of 630 feet. The full length and width, or 1,470 square yards, was surfaced 8 inches thick with gravel, hauled one-half mile. The maximum cut was 2 feet, the maximum fill 4 feet, and the maximum grade of 8 per cent on the old road was reduced to 6 per cent on the new road.

The total cost of the work was $346.19, or $0.235 per square yard.

Dorset, Vt. (No. 5).—Work was begun on a gravel section extending north from the cemetery toward the hotel on the village road June 16, 1913, and completed on October 11, 1913, with a loss of 81 days for various causes. The adjacent land is rolling and the natural soil is clay.

The road was graded 27 feet wide in both cuts and fills for a distance of 627 feet. The maximum fill was 1 foot and the maximum grade on the old road of 2 per cent was reduced to 0.3 per cent on the new road. The gravel, which was hauled 1 mile, was laid 8 inches thick and 23 feet wide, making an area of 1,603 square yards. Transverse leeches of screened gravel were placed frequently.

One 3 by 3 foot dry masonry culvert was built.

The total cost of the work was $392.39, or $0.244 per square yard.

Glastonbury, Vt.—Work was begun on a gravel road extending south from Glastonbury toward South Shaftsbury June 2, 1913, and completed August 30,

1913. Fifty-eight days were lost from various causes. The adjacent land is mountainous and the natural soil is gravel.

The road was graded 18 feet wide in both cuts and fills for a distance of 600 feet. An area of 1,066 square yards was surfaced 16 feet in width and 6 inches thick with gravel, hauled one-half mile in stone boats. The maximum cut was 4 feet, the maximum fill 2 feet, and the maximum grade of 8 per cent was reduced to 5 per cent.

Three 20-foot stone culverts were built, 10, 12, and 24 inches, respectively, in diameter.

The total cost of the work was $289, or $0.271 per square yard.

LANDGROVE, VT.—Work was begun on a gravel section on the Ideal Tour Road east from Landgrove Hollow toward Londonderry June 10, 1913, and completed August 30, 1913, with 39 days lost from various causes. The adjacent land is mountainous and the soil rocky throughout.

The road was graded to a width of 21 feet in both cuts and fills for a distance of 650 feet. The maximum cut was 2 feet and the maximum fill 5 feet. The maximum grade on the old road was 14 per cent, which was reduced to 8 per cent on the new road. A surface of pit gravel was laid to a width of 14 feet, 8 inches thick, making a surfaced area of 1,011 square yards.

Two metal culverts, 24 feet long and 16 and 24 inches in diameter, were placed at a cost of $48. The total cost of the road, exclusive of culverts, was $472.48, which is at the rate of $0.4673 per square yard.

The equipment consisted of plows, shovels, slat-bottom wagons, rakes, harrows, and a split-log drag. Labor cost $1.75 per day, foreman $2.25 per day, and teams $4 per day of 9 hours.

MANCHESTER, VT.—Work was begun on a hardpan gravel road extending north from Manchester toward Peru August 18, 1913, and completed October 18, 1913. Seven days were lost on account of bad weather. The adjacent land is rolling and the natural soil sand and stone.

The road was graded 26 feet wide in both cuts and fills for a distance of 2,310 feet. The maximum cut was 3 feet, the maximum fill 2 feet, and the maximum grade of 7 per cent was reduced to 4 per cent. A natural surfacing of hardpan 22 feet wide, making an area of 5,646 square yards, was laid after being hauled 1 mile.

Two 2 by 2 foot concrete culverts were built and two 12-inch metal-pipe culverts were laid.

The total cost of the work was $1,427.58, or $0.253 per square yard.

PERU, VT. (No. 1).—Work was begun on a hardpan gravel section extending east from Peru toward Landgrove on the Ideal Tour Road June 1, 1913, and completed October 25, 1913, with a loss of 98 days for various causes. The adjacent land is hilly and the natural soil is clay gravel.

The road was graded 26 feet wide in both cuts and fills for a distance of 644 feet. The maximum cut was 1 foot, the maximum fill 4 feet, and the maximum grade of 6 per cent was not changed. The road was surfaced 22 feet wide, making an area of 1,574 square yards, with a natural clay-gravel "hardpan."

One 3½ by 4 foot dry-stone culvert was built.

The total cost of the work was $237.48, or $0.150 per square yard, of which $39.25 was expended for the culvert.

PERU, VT. (No. 2).—Work was begun on a gravel road extending east from Peru toward Landgrove on the Ideal Tour Road May 19, 1913, and completed November 22, 1913. The time lost from various causes was 73 days. The adjacent land is hilly and the natural soil is loam and gravel.

The road was graded 21 feet wide in both cuts and fills for a distance of 5,313 feet. The maximum cut was 6 feet, the maximum fill 4 feet, and the maximum grade of 11 per cent on the old road was reduced to 8 per cent.

The road was surfaced full width, or an area of 12,397 square yards, with gravel from within the road limits and from pits alongside the road.

Three 24-foot stone culverts were built of the following dimensions: 4 by 2.5 feet, 2 by 2.5 feet, and 2 by 2 feet.

The total cost of the work was $2,001.89, or $0.161 per square yard.

Pownal, Vt.—Work was begun on a road extending north from Pownal toward North Pownal on September 8, 1913, and completed on October 18, 1913, with five days lost from various causes. The adjacent land is hilly and the natural soil is gravel and clay.

The road was graded 24 feet wide in both cuts and fills for a distance of 1,500 feet. The maximum cut was 2 feet, the maximum fill 2 feet, and the maximum grade of 6 per cent on the old road was reduced to 4 per cent on the new road. A natural gravel was obtained from a near-by source and the road surfaced 22 feet wide, or an area of 3,666 square yards. Telford foundation 12 feet wide and 2 feet thick was placed on 800 feet of this road.

The total cost of the work was $839.56, or $0.228 per square yard.

Readsboro, Vt.—Work was begun on a "hardpan" gravel road extending east from Heartwellville toward Readsboro on August 25, 1913, and completed on September 13, 1913. The time lost on account of bad weather was two days. The adjacent land is hilly and the natural soil is "hardpan."

The road was graded 19 feet wide in both cuts and fills for a distance of 1,000 feet. The maximum fill was 3 feet and the maximum grade of 3 per cent on the old road was reduced to 1 per cent. The road was surfaced by hauling in hardpan and leveling it with a split-log drag.

The total cost of the work was $400, or $0.190 per square yard.

Rupert, Vt. (No. 1).—Work was begun on a gravel road extending east from Rupert toward Dorset on May 19, 1913, and completed on August 22, 1913, with 10 days lost on account of bad weather. The adjacent land is hilly and the natural soil is a slate gravel.

The road was graded 24 feet wide in both cuts and fills for a distance of 4,050 feet. The maximum cut was 2 feet, the maximum fill 6 feet, and the maximum grade of 6 per cent on the old road was reduced to 4 per cent on the new road. Gravel from a near-by pit was laid for a width of 18 feet, or an area of 8,100 square yards.

One 12-inch and one 24-inch corrugated-iron pipe culverts were laid; also one 3 by 2 foot concrete box culvert.

The total cost of the work, including culverts, was $2,099.78, or $0.259 per square yard.

Rupert, Vt. (No. 2).—Work was begun on a gravel road extending north from Rupert toward Pawlet on September 1, 1913, and completed on September 16, 1913, with one day lost on account of bad weather. The adjacent land is level and swampy and the natural soil is gravel and loam.

The road was graded 18 feet wide in both cuts and fills for a distance of 495 feet. The maximum fill was 5 feet and the maximum grade of 2 per cent on the old road was reduced to 1 per cent on the new road. A gravel surface obtained from the river bed was laid the full width, a total area of 990 square yards.

The total cost of the work was $704.28, or $0.71 per square yard.

Sandgate, Vt.—Work was begun on a gravel section on the Bear Mountain Road north from Sandgate toward Bear Mountain on August 18, 1913, and was entirely completed October 15, 1913, with seven days' loss of time on account of bad weather. The adjacent land is mountainous and the soil is a clay.

The road was graded 18 feet wide in cuts and fills for a distance of 1,171 feet. The maximum cut was 4 feet, the maximum fill 2 feet, and the original maximum grade, which was 9 per cent, was reduced to 6 per cent. A surface of unrolled gravel was laid for 1,171 feet, 14 feet wide, making 1,821 square yards. The gravel used was obtained from the side of the road.

Two stone culverts 2 by 2 by 20 feet were placed.

The total cost of the completed road was $514.51, which is at the rate of $0.2825 per square yard, including drainage structures. Labor cost $1.75 per day, foreman $2 per day, and teams $4 per day of 9 hours.

Searsburg, Vt.—Work was begun on June 2, 1913, surfacing with hardpan the road extending east from Searsburg toward Wilmington, and was entirely completed on October 25, 1913, with a loss of 31 days from various causes. The adjacent land is mountainous and the soil is clay. The road was graded 20 feet wide in both cuts and fills for a distance of 1,006 feet. The maximum cut was 2 feet and the maximum fill 4 feet. The maximum grade of 10 per cent was reduced to 8 per cent. A surface of hardpan was laid 12 feet wide for 1,006 feet, making 1,341 square yards. This hardpan was obtained from a pit at the roadside.

Six 20-foot metal culvert pipes 20 inches in diameter were placed at a cost of $141.

The principal items of cost were as follows: Labor, $1,213.58; dynamite, $41; and road drag, $2.50; making a total of $1,257.08, which is at the rate of $0.9374 per square yard, or $6,594.72 per mile, exclusive of drainage structures.

Labor was paid $1.75 per day, foreman $2.25 per day, teams $4 per day of 9 hours.

Shaftsbury, Vt. (No. 1).—Work was begun on a gravel road extending west from Sodom toward New York on May 26, 1913, and completed September 20, 1913. Sixty-one days were lost for various causes. The adjacent land is hilly and the natural soil is clay.

The road was graded 22 feet wide in both cuts and fills for a distance of 1,000 feet. The maximum cut was 4 feet, the maximum fill 2 feet, and the maximum grade of 9 per cent was reduced to 4 per cent. A surface of gravel from near-by pits was laid 14 feet wide, making an area of 1,555 square yards.

Two 24-inch metal culverts were laid and 750 feet of underdrain was constructed.

The total cost of the work, including culverts, was $872.35, or $0.560 per square yard.

Shaftsbury, Vt. (No. 2).—Work was begun on a gravel road running south from West Shaftsbury toward New York on August 18, 1913, and finished on September 19, 1913. Three days were lost on account of bad weather. The adjacent land is hilly and wet and the natural soil is clay.

The road was graded 22 feet wide for a distance of 1,060 feet. The maximum cut was 2 feet, the maximum fill 5 feet, and the maximum grade of 9 per cent on the old road was reduced to 4 per cent on the new road. A surface of river gravel from New York was laid 12 feet wide, making an area of 1,413 square yards.

One 24-inch and two 12-inch metal culverts with concrete head walls were built, and a berm ditch of the flare type was used.

The total cost of the work, including culverts, was $936.40, or $0.661 per square yard.

STAMFORD, VT.—Work was begun on a "hardpan" gravel road extending northeast from Stamford toward Heartwellville on August 4, 1913, and completed on August 30, 1913, with two days lost on account of rain. The adjacent land is hilly and the natural soil is loam.

The road was graded 21 feet wide in both cuts and fills for a distance of 1,419 feet. The maximum cut was 3 feet, the maximum fill 1 foot. A surface of hardpan from a near-by pit was laid 14 feet wide, making a surfaced area of 2,207 square yards.

Four hundred feet of blind drain was built.

The total cost of the work was $409.50, or $0.186 per square yard.

WINHALL, VT.—Work was begun on a "hardpan" gravel road extending east from Bondville toward Manchester on August 4, 1913, and completed on September 27, 1913. Six days were lost on account of bad weather. The adjacent land was hilly and the natural soil is hardpan and bowlder ledges.

The road was graded 21 feet wide in both cuts and fills for a distance of 2,450 feet. The maximum cut was 20 feet, the maximum fill 6 feet, and the maximum grade of 14 per cent on the old road was reduced to 8 per cent. The road was surfaced with hardpan and gravel, obtained along the roadside.

Two 12-inch and two 18-inch metal culverts, 22 feet long, were laid.

The total cost of the work, including culverts, was $1,075.53.

EARTH ROAD.

POWNAL, VT. (No. 1).—Work was begun October 20, 1913, on an earth road extending south from Bennington to Pownal and was completed November 29, 1913, with a loss of nine days on account of rain. The adjacent land is hilly and swampy and the soil a loam.

The road was graded 20 feet wide in cuts and fills for a distance of 1,450 feet. The maximum cut was 2 feet, the maximum fill 3 feet, and the grade was not changed. Material for a telford foundation was obtained from old stone walls along the roadside and laid 12 feet wide for 1,200 feet. After grading, the earth was then leveled over the rock. It was intended to surface this road with gravel later.

The total cost of the work was $816.21, which is at the rate of $0.253 per square yard, or $2,942.50 per mile. Labor cost $1.75 per day; foreman, $2.50 per day; and teams, $4.50 per day of nine hours.

POWNAL, VT. (No. 2).—Work was begun on an earth road extending north from Pownal Center toward Bennington on May 5, 1913, and completed on September 6, 1913, with 15 days lost on account of rain and bad weather. The adjacent land is hilly and the natural soil is loam, bowlders, and gravel.

The road was graded 22 feet wide in both cuts and fills for a distance of 3,600 feet. The maximum cut was 24 feet, the maximum fill 3 feet, and the maximum grade of 8 per cent on the old road was reduced to 6 per cent.

One 2 by 1½ foot stone culvert was built at a cost of $14.

The total cost of the work was $1,815.77, or $0.206 per square yard.

READSBORO, VT. (No. 1).—Work was begun on an earth road extending east from Falls toward Readsboro on May 21, 1913, and completed on October 11,

1913. Thirty days were lost from various causes. The adjacent land is mountainous and the natural soil is hardpan.

The road was graded 18 feet wide in both cuts and fills for a distance of 4,046 feet. The maximum cut was 30 feet, the maximum fill 9 feet, and the maximum grade of 11 per cent on the old road was reduced to 7 per cent.

Seven stone culverts 2 by 2 by 20 feet were built; also two 18-inch metal culverts. Leeches were placed every 200 feet. Much heavy stumping was done and a bowlder ledge was removed.

The total cost of the work, including culverts, was $2,526.58, or $0.312 per square yard.

Readsboro, Vt. (No. 2).—Work was begun on an earth road extending east from Readsboro toward Whitingham on July 28, 1913, and completed on October 11, 1913. Forty-five days were lost on account of various causes. The adjacent land is mountainous and the natural soil is hardpan, which was used for surfacing the road.

The road was graded 18 feet wide in both cuts and fills for a distance of 850 feet. The maximum cut was 10 feet, the maximum fill 1 foot. A guard rail was built the full length of the road on one side.

The total cost of the work was $390.78, or $0.230 per square yard.

Shaftsbury, Vt. (No. 1).—Work was begun on an earth road extending north from Shaftsbury Depot toward Arlington on October 13, 1913, and completed on November 19, 1913. Bad weather caused a delay of 10 days. The adjacent land is hilly and the natural soil is hardpan, which was used in the surfacing.

The road was graded 22 feet wide in both cuts and fills for a distance of 1,056 feet. The maximum cut was 19 feet, the maximum fill 2 feet, and the maximum grade was reduced from 8 per cent to 6 per cent.

One double 24-inch metal culvert was laid.

The total cost of the work, including culverts, was $778.02, or $0.301 per square yard.

Shaftsbury, Vt. (No. 2).—Work was begun on a section of the Coal Hill Road south from South Shaftsbury toward Bennington November 20 and was completed on November 27, 1913. The adjacent land is hilly, and the natural soil is clay.

The road was graded 22 feet wide in cuts and fills for a distance of 528 feet. The maximum cut was 9 feet and the maximum fill 2 feet.

One 24-inch metal culvert 26 feet long was placed at a cost of $46.86.

The total cost of the completed road, exclusive of drainage structures, was $89.74, which is at the rate of $0.070 per square yard, or $897.40 per mile.

Sunderland, Vt.—Work was begun on an earth road east from Sunderland toward Arlington June 23, 1913, and the road was completed on September 27, 1913, with a loss of nine days on account of bad weather. The adjacent land is hilly and the natural soil loam and sand.

The road was graded 21 feet wide in cuts and fills for a distance of 4,356 feet. The maximum cut was 10 feet and the maximum fill 3 feet. The maximum grade of 10 per cent on the old road was reduced to a maximum of 7 per cent on the new road. The improvement consisted essentially in widening a 6-foot road to 21 feet and in placing gravel, obtained from the roadside, over the sandy portions.

One 12-inch metal-pipe culvert 24 feet long was placed at a cost of $22.70.

The total cost of the road, exclusive of drainage structures, was $713.46, which is at the rate of $0.070 per square yard, or $864.82 per mile. Labor costs $1.75 per day, foreman $2.50 per day, and teams $4 per day of nine hours.

Woodford, Vt.—Work was begun on an earth road running east from the city of Woodford toward Bennington on August 30, 1913, and completed on October 25, 1913. The time lost from various causes was 20 days. The adjacent land is mountainous, and the natural soil is clay, which was used for surfacing.

The road was graded 22 feet wide in both cuts and fills for a distance of 1,396 feet. The maximum cut was 6 feet, the maximum fill 5 feet, and the maximum grade was reduced from 17 per cent to 8 per cent.

Nine 12-inch and one 24-inch metal culverts and 396 feet of side drain were constructed.

The total cost of the work, including culverts, was $686.24, or $0.201 per square yard.

Rutland County, Vt.

BITUMINOUS MACADAM.

Pittsford, Vt.—Work was begun on a bituminous macadam road on the main line from Pittsford to Rutland July 14, 1913, and completed November 1, 1913, with a delay of 14 days for various causes. The adjacent land is hilly on the east and rolling on the west. The natural soil is sandy loam.

The road was graded 30 feet wide in both cuts and fills for a distance of 1,544 feet. The maximum cut was 1.2 feet, the maximum fill 3 feet, and the maximum grade of 1.3 per cent on the old road was reduced to 0.8 per cent. A surface of bituminous macadam was laid 16 feet wide, or for 2,745 square yards, in the following manner: Local crushed stone was placed in two 3-inch compacted courses. A bituminous material was then applied as a binder by the penetration method, using 1½ gallons per square yard. A one-half gallon flush coat was finally applied.

Three 18-inch corrugated-iron pipe culverts were laid. Two masonry culverts were repaired and lengthened, and a telford base was laid from station 4 to station 8+25.

The total cost of the work, including culverts, was $3,420.99, which is at the rate of $11,698.37 per mile, or $1.246 per square yard.

GRAVEL ROADS.

Benson, Vt. (No. 1).—Work was begun on a gravel road extending east from Benson, toward Hortonville, on September 2, 1913, and completed on September 20, 1913. Two days were lost on account of bad weather. The adjacent land is hilly and the natural soil is clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 462 feet. The maximum cut was 1 foot; the maximum fill, 1.5 feet; the old maximum grade, 3 per cent; and the new maximum grade, 1.3 per cent. A surface of gravel 21 feet in width, making 1,078 square yards, was placed. The gravel was obtained from pits alongside the road.

One corrugated-iron pipe culvert 18 inches in diameter was placed.

The total cost for the work was $184.83, or at the rate of $0.171 per square yard.

Benson, Vt. (No. 2).—Work was begun on a gravel section, starting at a point 3 miles east of Benson on the main road toward Hortonville, on August 1, 1913. It was completed on August 30, 1913, with a loss of five days from various causes. The adjacent land is hilly and the natural soil brown, stiff clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 2,657 feet. The maximum cut was 3 feet; the maximum fill, 3.5 feet. The maximum grade on the old road was 10 per cent and on the new road 7 per cent. Bank gravel for surfacing was obtained from pits along the roadside and placed 21 feet wide for the entire graded length, or a total area of 6,200 square yards.

Three corrugated-iron pipe culverts were placed.

The total cost of the work was $339.55, or $0.055 per square yard.

Benson, Vt. (No. 3).—Work was begun graveling a section of the turnpike extending from the north town line toward Fairhaven on May 15, 1913, and completed on June 1, 1913. The adjacent land is hilly and the natural soil seems to be about half sandy loam and half brown stiff clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 891 feet. The maximum fill was 2.5 feet and the maximum grade was reduced from 1 per cent to 0.7 per cent. The graded earth was covered with waste from a slate quarry for its entire length. Gravel was then placed 21 feet wide, making an area of 2,079 square yards.

One 4 by 8 foot culvert was repaired by placing a new floor.

The total cost of the work was $432.83, or $0.208 per square yard.

Benson, Vt. (No. 4).—Work was begun on a gravel section extending north from the south town line on the stage road toward Benson April 30, 1913, and completed May 12, 1913, with a loss of two days, due to bad weather. The adjacent land is hilly and the natural soil is a brown clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,584 feet. The maximum cut was 1 foot and the maximum fill 1.2 feet. The maximum grade of 2.5 per cent on the old road was reduced to 1.5 per cent on the new road. Gravel was obtained from banks near by and laid 21 feet in width, making an area of 3,696 square yards.

One 15-inch corrugated-iron pipe culvert was replaced and one 2 by 2 foot masonry culvert was lengthened.

The total cost of the work was $198.45, or $0.054 per square yard.

Brandon, Vt.—Work was begun on a gravel road extending north from Brandon toward Salisbury on August 2, 1913, and completed on August 30, 1913. The adjacent land is rolling, and the natural oil is sand and a sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,188 feet. The old road was very sandy, and after it had been widened and straightened a 3-inch layer of clay was applied on the subgrade before putting on the gravel. A surface of gravel was then placed 21 feet in width, making 2,772 square yards. This was compacted with a 3-ton horse roller.

Two small concrete culverts and one 18-inch corrugated-iron pipe culvert were placed.

The total cost was $635.40, or $0.229 per square yard.

Castleton, Vt.—Work was begun on a gravel road extending south from Castleton toward Poultney on September 20, 1913, and completed October 20, 1913. Three days were lost on account of rain. The adjacent land is rolling, and the natural soil is sand.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,287 feet. The new road was widened and, where necessary, raised, making the fill of rocks and old brick. The voids were well filled with chips before surfacing. The maximum fill was 2.5 feet. A surface of gravel was laid 21 feet wide, making an area of 3,003 square yards.

Two small corrugated-iron pipe culverts were laid.

The total cost of the work was $430.88, or $0.143 per square yard.

CASTLETON FOUR CORNERS, VT.—Work was begun October 23, 1913, and completed November 7, 1913, resurfacing the old State road, extending west from Castleton Four Corners toward Hydeville, with gravel.

No grading was done, simply a surface of bank gravel was placed 21 feet wide for a total distance of 2,558 feet, or a total surface area of 5,969 feet.

The total cost was $322.80, or $0.054 per square yard.

CENTER RUTLAND, VT.—Work was begun September 1, 1913, on a gravel road starting at a point 1½ miles north of Center Rutland and extending toward Proctor. It was completed on October 1, 1913, and only two days were lost on account of bad weather. The adjacent land is rolling and the natural soil is clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,188 feet. The maximum cut was 2.5 feet, the maximum fill 1.9 feet, and the maximum grade was reduced from 3.9 per cent to 2.5 per cent. The road was surfaced with bank gravel for a width of 21 feet, or a total area of 2,772 square yards.

One 5 by 3 foot and one 2 by 3 foot masonry culvert and one 18-inch corrugated-iron pipe culvert were placed.

The total cost of the work, including culverts, was $596.75, or $0.215 per square yard.

CHITTENDEN, VT. (No. 1).—Work was begun on a gravel road extending east from Chittenden toward North Sherburne on August 15, 1913, and completed on August 30, 1913. The adjacent land is hilly and the natural soil is loam.

This strip of road is paralleled by a mountain stream, and it was necessary to build a retaining wall to protect the road. A 2-foot fill was made with borrowed material. The road was graded 26 feet wide in both cuts and fills for a distance of 350 feet. The maximum cut was 1 foot; the maximum fill, 2 feet. The maximum grade of 4 per cent was reduced to 2.8 per cent. A surface of bank gravel was laid, 21 feet in width, making an area of 817 square yards.

One 15-inch corrugated-iron culvert was placed.

The total cost of the work was $344.66, or $0.422 per square yard.

CHITTENDEN, VT. (No. 2).—Work was begun September 10, 1913, on a gravel road extending from 3 miles east of Chittenden toward North Sherburne. It was completed on September 30, 1913, with two days lost on account of rain. The adjacent land is hilly, and the natural soil is clay loam. The old road was very swampy, poorly drained, and low.

The maximum cut was 0.8 foot and the maximum fill was 1 foot. The road was graded 26 feet wide in cuts and fills for a distance of 500 feet. A surface of bank gravel was laid 21 feet wide, making an area of 1,166 square yards.

One 2 by 2 foot masonry culvert was lengthened and one 18-inch corrugated-iron pipe culvert placed.

The total cost of the work was $336.69, or $0.288 per square yard.

CLARENDON, VT.—Work was begun September 1, 1913, on a gravel section extending south on the Creek Road from Rutland to Wallingford. It was completed on December 14, 1913, with five days lost on account of bad weather. The adjacent land is level on the east end of the road and hilly on the west. The natural soil is clay and sandy loam, equally divided, with rock outcrops in places.

The road was graded to a width of 26 feet in both cuts and fills for a distance of 7,499 feet. More than $1,500 of the amount expended was used in rockwork to widen the road for a distance of 550 feet. In some places the ledge was 18 feet high. Before this was removed the road was only 12 feet wide. At station 40 a bad curve was eliminated by cutting through a hill and constructing a retaining wall 12 feet high. Smaller retaining walls were built at various other places and guard rails placed where necessary. The maximum cut was 4 feet and the maximum fill 3.5 feet. The maximum grade on the old road was 6 per cent, which was reduced to a maximum of 3 per cent on the new road. The surfacing material used was an excellent quality of bank gravel. It was laid 21 feet wide, a total area of 17,497 square yards.

Ten small culverts were built.

Labor cost $1.75 and $2 per day, foreman $4 per day, and teams $4.50 per 9-hour day. The total cost of the work was $6,387.90, or $0.365 per square yard.

CUTTINGSVILLE, VT.—Work was begun on a gravel loam road beginning 2 miles north of Cuttingsville and extending northwest toward East Clarendon on August 2, 1913, and completed on September 3, 1913. Three days were lost on account of rain. The adjacent land is hilly and the natural soil is loam.

The road was graded 26 feet in width in both cuts and fills for a distance of 1,023 feet. Considerable clearing and grubbing was necessary, and a section of retaining wall was built. The maximum cut was 0.5 foot, the maximum fill 3 feet, and the maximum grade was reduced from 4 per cent to 2.5 per cent. A surface of gravel loam from the excavated material was laid 20 feet wide, making an area of 2,387 square yards.

One 12-inch and one 18-inch corrugated-iron pipe culvert were laid.

The total cost of the work, including culverts, was $480.77, or $0.201 per square yard.

DANBY FOUR CORNERS, VT.—Work was begun on a gravel road extending west from Danby Four Corners toward Pawlet on August 1, 1913, and completed on August 10, 1913. The adjacent land is hilly and the natural soil is a sandy loam.

The road was graded 26 feet wide in cuts and fills for 350 feet. A surface of bank gravel was laid 21 feet wide, making an area of 817 square yards.

One 18-inch corrugated-iron pipe culvert was placed.

The total cost of the work was $161, or $0.197 per square yard.

DANBY, VT. (No. 1).—Work was begun August 10, 1913, on a gravel road beginning at a point 3 miles south of Danby and extending south toward the Bennington County line. It was completed November 15, 1913, with a loss of 12 days on account of various causes. The adjacent land is hilly on the west and level on the east side. The natural soil is sand and sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 2,360 feet. Considerable rock excavation was done and 900 linear feet of retaining wall was built from 2 to 8 feet high. The maximum cut was 2 feet, the maximum fill 2 feet, and the maximum grade was reduced from 3 to 1.5 per cent. A surface of gravel was laid 21 feet wide, making an area of 5,507 square yards. The average haul of surfacing was 1 mile.

Six corrugated-iron pipe culverts were laid.

The total cost of the work was $1,832.28, or $0.333 per square yard.

Danby, Vt. (No. 2.)—Work was begun on a gravel road extending from a point 1½ miles east of Danby toward Danby Four Corners on August 15, 1913, and completed September 1, 1913. The adjacent land is hilly and the natural soil is clay.

The maximum cut was 3 feet, the maximum fill 2½ feet, and the maximum grade of 11 per cent was reduced to 9 per cent on the new road. The road was graded 26 feet wide in cuts and fills for a distance of 545 feet. A retaining wall averaging 7 feet in height for 100 feet in length was built and considerable rock was removed during the grading. A bank gravel surface was laid for a width of 21 feet, making an area of 1,272 square yards.

One 18-inch corrugated-iron pipe culvert was placed and one 3 by 3 foot masonry culvert lengthened.

The total cost of the work was $412.03, or $0.324 per square yard.

Danby, Vt. (No. 3).—Work was begun September 15, 1913, on a gravel road extending from a point 2 miles north of Danby Post Office on the Creek Road toward Wallingford and completed on October 30, 1913. Five days were lost from various causes. The adjacent land is hilly and the natural soil is clay and sand rock.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,452 feet. The maximum cut was 3 feet; the maximum fill, 4.2 feet. The maximum grade of the old road was 10.5 per cent, which was reduced to 7 per cent on the new road. A surface of bank gravel 21 feet wide was laid, making an area of 3,388 square yards.

Two masonry culverts were repaired and two 18-inch corrugated-iron pipe culverts placed.

The total cost of the work was $1,528.69, or $0.451 per square yard.

East Wallingford, Vt. (No. 1).—Work was begun on a gravel road starting 2½ miles east of East Wallingford and extending toward Mount Holly on August 12, 1913, and completed September 30, 1913, with three days lost on account of rain. The adjacent land is hilly and the natural soil clay loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,700 feet. The maximum cut was 3.5 feet, the maximum fill 3 feet, and the maximum grade of 8 per cent was reduced to 5 per cent on the new road.

Three hundred feet of telford foundation was placed, and the whole road was surfaced for a width of 21 feet with bank gravel. The surfaced area was 3,967 square yards.

Four corrugated-iron pipe culverts and one 2 by 2 foot concrete box culvert were laid.

The total cost of the work was $861.70, or $0.217 per square yard.

East Wallingford, Vt. (No. 2).—Work was begun October 2, 1913, on a gravel section 4 miles southeast from East Wallingford and extending toward Weston, on the road locally known as the "Clay Hole." It was completed November 1, 1913, and two days were lost on account of rain. The adjacent land is hilly and the natural soil clay.

The road was graded 26 feet in width in both cuts and fills for a distance of 578 feet. The maximum fill was 2 feet and the maximum grade was reduced from 3 to 1.5 per cent. The V foundation was covered with bank gravel to a width of 21 feet, giving a surfaced area of 1,349 square yards.

One stone masonry culvert was lengthened, and regulation stone and tile cross drains were put in every 20 feet to drain the V foundation, which was laid of fence stone.

The total cost of the work was $303.26, or $0.225 per square yard.

Fair Haven, Vt. (No. 1).—Work was begun August 1, 1913, on a gravel road beginning at the line between the townships of Fair Haven and Castleton and extending west toward the village of Fair Haven, and completed on August 10, 1913. The adjacent land is rolling and the soil is sandy loam.

The road was shaped 26 feet wide in both cuts and fills for a distance of 743 feet. A surface of bank gravel was placed 21 feet wide, making an area of 1,734 square yards.

One 18-inch corrugated-iron pipe culvert was placed.

The total cost of the work was $165.20, or $0.095 per square yard.

Fair Haven, Vt. (No. 2).—Work was begun on a gravel road extending west from Fair Haven toward Whitehall, N. Y., on August 12, 1913, and completed on September 3, 1913, with one day lost on account of rain. The adjacent land is rolling and the natural soil very sandy.

The old road was lightly shaped and a 3-inch layer of clay applied on the sand subgrade before putting on the gravel surface. The road was graded 26 feet wide in both cuts and fills for a total length of 2,970 feet. A gravel surface 21 feet wide, making an area of 6,930 square yards, was placed.

One 15-inch and one 18-inch corrugated-iron pipe culvert were placed.

The total cost of the work was $687.54, or $0.099 per square yard.

Fair Haven, Vt. (No. 3).—Work was begun September 15, 1913, on a gravel road extending north from Fair Haven toward West Castleton at the point known as Scotch Hill. It was completed on October 15, 1913, with three days lost on account of bad weather. The adjacent land is hilly, and the natural soil is clay from station 0 to 6 and sandy loam from station 6 to 12+20.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,220 feet. The maximum grade was reduced from 7 to 5 per cent. The maximum cut was 2 feet and the maximum fill was 1.8 feet. The material for the telford foundation, which extended for 400 feet of the clay portion, was obtained from stone walls. The gravel surfacing came from banks along the road and was laid 21 feet in width, a total area of 2,847 square yards.

One 18-inch corrugated-iron pipe culvert was laid.

The total cost of the work was $420.38, or $0.148 per square yard.

Fair Haven, Vt. (No. 4).—Work was begun October 18, 1913, on a gravel road extending northwest from Fair Haven toward Benson, beginning at a 12-foot iron bridge 3 miles north of Fair Haven. It was completed on November 7, 1913, with one day lost on account of rain. The adjacent land is hilly and the natural soil is clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 578 feet. The maximum cut was 1 foot and the maximum fill was 1 foot. The maximum grade of 5 per cent on the old road was reduced to 4 per cent on the new road. A surface of bank gravel was laid 21 feet in width, making an area of 1,349 square yards.

The total cost of the work was $368.66, or $0.273 per square yard.

HOLDEN, VT. (No. 1).—Work was begun August 10, 1913, on a gravel section extending west from Holden on the Saw Mill Hill Road toward Grangerville. It was completed on September 15, 1913, with four days lost from various causes. The adjacent land is very hilly and the natural soil is clay and hardpan.

The road was graded 25 feet wide in both cuts and fills for a distance of 751 feet. The maximum cut was 2 feet and the maximum fill was 3.7 feet. The maximum grade of 13.5 per cent was reduced to 8.5 per cent. This was sidehill work, necessitating the construction of a retaining wall the entire length. The gutters were paved and guard rail erected. The road was surfaced 20 feet wide with bank gravel, making an area of 1,669 square yards.

One 18-inch corrugated-iron pipe culvert was placed and one 5 by 4 foot masonry culvert lengthened.

The total cost of the work was $641.80, or $0.384 per square yard.

HOLDEN, VT. (No. 2).—Work of improving the road extending northeast from Grangerville toward Holden was begun on September 20, 1913, and completed September 25, 1913. The adjacent land is hilly.

The work consisted in resurfacing with bank gravel 330 feet of old road to a width of 20 feet, making 733 square yards.

The cost of the work was $41.75, or $0.057 per square yard.

HUBBARDTON, VT.—Work was begun August 20, 1913, on a gravel road starting 3 miles north of Hubbardton Post Office at Beebe Pond and extending toward Sudbury. It was completed on October 31, 1913, with five days lost on account of various causes. The adjacent land is hilly and the natural soil is clay loam.

The road was graded 26 feet wide in both cuts and fills for a total distance of 759 feet. The maximum cut was 4 feet, the maximum fill 3 feet, and the grade of 9 per cent was reduced to 6 per cent. Considerable rock excavation was necessary and steam drills were employed. A heavy riprap wall was built almost the entire length and a guard rail erected.

Two 12-inch corrugated-iron pipe culverts were placed.

A surface of gravel was laid 21 feet in width, making an area of 1,771 square yards.

The total cost of the work was $1,139.55, or $0.643 per square yard.

HYDEVILLE, VT.—Work was begun on a gravel road extending west from Hydeville toward Fair Haven on August 10, 1913, and completed on September 11, 1913. Three days were lost on account of rain.

The road was graded 26 feet wide in both cuts and fills for a total distance of 1,634 feet. The maximum cut was 1 foot and the maximum fill 2.5 feet. Retaining walls were built to hold the fill and probably half of the excavation was rock. The maximum grade was reduced from 4 to 2.3 per cent. Gravel was obtained from banks nearby, and surfaced 21 feet in width, making 3,812 square yards.

Two 18-inch iron pipe culverts were laid, and 510 feet of 4-inch tile drain was placed under the north ditch line for subdrainage.

The total cost of the work was $1,039.77, or $0.272 per square yard.

IRA, VT.—Work was begun August 18, 1913, on a road extending northeast from Ira toward West Rutland, starting 3 miles northeast of Ira Church. It was completed on October 30, 1913, with a loss of five days from various causes.

This road parallels a stream which formerly washed out the road every spring. The channel of the stream was cleared of large bowlders and trees and a retaining wall was constructed. A 2-foot fill running the entire length of the work was then made of stone from old walls. This rock was carefully chinked with small stone and covered with gravel.

The road was graded 26 feet wide in both cuts and fills for a distance of 660 feet. The maximum fill was 3 feet and the maximum grade of 2 per cent was reduced to 1 per cent. A bank gravel surfacing was laid 21 feet wide, making an area of 1,540 square yards.

Two 2 by 3 foot masonry culverts with concrete tops were laid; also one 18-inch corrugated-iron pipe culvert.

The total cost of the work was $1,406.85, or $0.913 per square yard.

Lake St. Catherine, Vt. (No. 1).—Work was begun August 1, 1913, on a gravel road starting at the iron bridge at the south end of Lake St. Catherine and extending north and then east toward Wells. It was completed on October 1, 1913, with a delay of four days on account of bad weather. The adjacent land is hilly and the natural soil from station 0 to 35 is sandy loam. The balance of the way is gravel.

The road was graded 26 feet wide in both cuts and fills for a distance of 4,673 feet. The maximum cut was 4.2 feet, the maximum fill 3.8 feet, and the maximum grade was reduced from 7 to 5.2 per cent.

A gravel surface 21 feet wide, making an area of 10,903 square yards, was laid, with a maximum haul of 1,500 feet for half the road. The gravel for the other half was obtained from banks alongside the road.

Three hundred feet of tile drain was constructed, two masonry culverts lengthened, one masonry culvert built, and five cast-iron pipe culverts laid.

The total cost of the work, including culverts, was $950.70, or $0.087 per square yard.

Lake St. Catherine, Vt. (No. 2).—Work was begun June 1, 1913, on a gravel road beginning at the north line of the town of Wells and extending south toward Poultney, paralleling the lake. It was completed on September 10, 1913, with a delay of 10 days from various causes. The adjacent land is very hilly on the east, with the lake on the west. The natural soil is soft shale and clay.

The road was graded 24 feet wide in both cuts and fills for a distance of 3,364 feet. The maximum cut was 5.7 feet, the maximum fill 6 feet, and the maximum grade was reduced from 10 to 4 per cent on the new road. The shale rock was practically all picked by hand, being too soft to blast. Bank gravel, which was hauled about 1 mile, was laid for a width of 18 feet on the road, making an area of 6,728 square yards.

Stone retaining walls were built; also one 4 by 4 foot concrete box culvert. Three 18-inch corrugated-iron pipe culverts were placed.

The total cost of the work, including culverts, was $2,720.46, or $0.404 per square yard.

Mendon, Vt. (No. 1).—Work was begun on a gravel section extending east from Mendon toward Sherburne on Mountain Road on August 20, 1913, and completed September 25, 1913. Five days were lost from various causes. The adjacent land is hilly and the soil a sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 446 feet. The maximum cut was 0.5 foot and the maximum fill 1 foot. A surface of gravel was laid 21 feet wide, making an area of 1,041 square yards. The gravel was hauled about 2½ miles.

One 18-inch corrugated-iron pipe culvert was built.

The total cost of the work was $414.12, or $0.398 per square yard.

Mendon, Vt. (No. 2).—Work was begun on a gravel section extending from a point one-half mile east of Mendon Post Office toward Sherburne on the Mountain Road on October 1, 1913, and completed October 31, 1913. The adjacent land is hilly and the natural soil is sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,071 feet. The maximum cut was 1 foot, the maximum fill 0.5 foot, and the grade of 4 per cent on the old road was reduced on the new road to 3 per cent. The gravel was hauled from a point 2 miles distant and laid on the road 21 feet wide, a total area of 2,499 square yards.

One 18-inch corrugated-iron pipe culvert was laid.

The total cost of the work was $389.57, or $0.156 per square yard.

Middletown Springs, Vt. (No. 1).—Work was begun August 15, 1913, on a gravel road extending west from Middletown Springs toward Poultney. It was completed on September 8, 1913, with three days lost on account of bad weather. The adjacent land is rolling and the natural soil is a sandy loam.

The road was graded 26 feet wide in both cuts and fills for a length of 627 feet. Gravel was hauled 3 miles for the surfacing and placed on the road to a width of 21 feet, or a total area of 1,463 square yards.

Two corrugated-iron pipe culverts were placed and one masonry culvert was lengthened.

The total cost of the work was $543.85, or $0.371 per square yard.

Middletown Springs, Vt. (No. 2).—Work was begun September 10, 1913, on a gravel road 2¾ miles from Middletown Springs and extending west toward Poultney. It was completed October 4, 1913, with a delay of two days on account of bad weather. The adjacent land is hilly and the natural soil is sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 396 feet. Gravel, which was hauled 3¾ miles, was laid on the road 21 feet wide, or a total of 924 square yards.

One masonry culvert was lengthened and one 18-inch corrugated-iron pipe culvert laid.

The total cost of the work was $132.63, or $0.143 per square yard.

North Pawlet, Vt.—Work was begun on a gravel road extending northwest from Spanktown toward Pawlet on October 1, 1913, and completed October 18, 1913, with a loss of one day on account of bad weather. The adjacent land is hilly.

The grade of the old road was not changed. The work consisted of blasting out shale rock to form the ditches and widening the road to 26 feet in both cuts and fills for a distance of 495 feet. It was then surfaced with bank gravel 21 feet wide, making an area of 1,155 square yards.

The total cost of the work was $134.30, or $0.116 per square yard.

Pittsfield, Vt.—Work was begun September 1, 1913, on a gravel road north of Pittsfield extending from the Stockbridge town line toward Stony Brook Station. It was completed on October 15, 1913, with two days lost on account of rain. The adjacent land is hilly and the natural soil on the first half of the road is sand, while the last half of the road is clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 594 feet. The maximum cut was 4 feet and the maximum fill 4 feet. The maximum grade of 11 per cent was reduced to 8 per cent. A telford base was laid for 60 feet. A surface of bank gravel 21 feet wide was laid, making an area of 1,386 square yards.

One 16-inch corrugated-iron pipe culvert was laid, and 320 feet of 6-inch tile drain was placed under the east ditch line through the cut.

The total cost of the work was $765.34, or $0.552 per square yard.

POULTNEY, VT.—Work was begun August 10, 1913, on a gravel road paralleling Lake St. Catherine and extending south from Poultney toward Wells. It was completed October 8, 1913, with three days lost on account of rain. The adjacent land is hilly and the natural soil is gravelly loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 2,393 feet. The maximum cut was 3.5 feet, the maximum fill was 2.8 feet, and the maximum grade was reduced from 4 to 2 per cent. Considerable grubbing and clearing was necessary in widening the road, and the excavated material was used for surfacing 21 feet in width, making an area of 5,583 square yards. The road was newly located for a distance of 400 feet.

Five corrugated-iron pipe culverts, ranging in size from 12 to 24 inches, were placed.

The total cost of the work, including drainage structures, was $1,427.36, or $0.255 per square yard.

PROCTOR, VT. (No. 1).—Work was begun on a gravel road extending north from Proctor toward Pittsford on June 1, 1913, and completed on August 1, 1913. Three days were lost on account of bad weather. The adjacent land is hilly and the natural soil is a sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 3,201 feet. The maximum cut was 3.7 feet, the maximum fill was 2.9 feet, and the old maximum grade of 8 per cent was reduced to 6 per cent. A gravel surface was laid 21 feet wide, making a total of 7,469 square yards.

Three 18-inch and two 24-inch corrugated-iron pipe culverts were placed and approximately 275 linear feet of telford base was laid.

The total cost of the work, including culverts, was $2,035.38, or $0.272 per square yard.

PROCTOR, VT. (No. 2).—Work was begun on a gravel road extending east from Proctor toward Pittsford Mills on August 4, 1913, and completed on September 1, 1913. Rain delayed the work for two days. The adjacent land is hilly and the natural soil a sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 710 feet. The maximum cut was 1.8 feet, the maximum fill was 1.2 feet, and the old maximum grade of 3 per cent was reduced to 2 per cent. Gravel was obtained close at hand and laid on the road 21 feet wide, or a total area of 1,656 square yards.

Two 18-inch and one 12-inch corrugated-iron pipe culverts were placed.

The total cost of the work, including culverts, was $221.21, or $0.133 per square yard.

RUTLAND CITY, VT.—Work was begun August 20, 1913, on a gravel road extending north from the south city line of Rutland toward Dorris Bridge. The road was entirely within the city limits and was completed on October 30, 1913, with a loss of three days on account of bad weather. The adjacent land is rolling on the west and level on the east side. The natural soil is sandy loam.

The road was shaped by a road machine 30 feet wide in both cuts and fills for a distance of 5,199 feet. Practically no grading was necessary. The road was surfaced with gravel 24 feet wide, making an area of 13,864 square yards. This gravel, which was hauled 3 miles, was compacted with a 10-ton roller.

Three 18-inch corrugated-iron pipe culverts were laid.

The total cost of the work, including culverts, was $3,874.47, or $0.279 per square yard.

RUTLAND, VT. (No. 1).—Work was begun August 1, 1913, on resurfacing with gravel a road extending north from the city line of Rutland toward Mill Village. It was completed August 10, 1913.

The road was surfaced with bank gravel for a width of 21 feet and a distance of 825 feet, making an area of 1,925 square yards.

The total cost of the work was $292.54, or $0.152 per square yard.

RUTLAND, VT. (No. 2).—Work was begun August 15, 1913, on a gravel section beginning at the south city line of Rutland on the Creek Road and extending south through Rutland Township to the Clarendon town line. Four days were lost on account of bad weather and it was completed on October 18, 1913. The adjacent land is rolling and the natural soil a sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 3,399 feet. The maximum cut was 1.8 feet, the maximum fill 3 feet, and the maximum grade was reduced from 3 to 1.5 per cent. The road was surfaced with bank gravel 21 feet in width, making an area of 7,931 square yards. A guard rail was erected along all the embankment.

One 6 by 4 foot, one 5 by 4 foot, and one 2 by 3 foot culvert were built of masonry and concrete, and one 18-inch and one 12-inch corrugated-iron pipe culvert were laid.

The total cost of the work, including culverts, was $2,796.42, or $0.352 per square yard.

SHERBURNE, VT.—Work was begun August 20, 1913, on a gravel section extending east of Mendon toward Sherburne, at practically the highest point on the Mountain Road. It was completed on October 21, 1913, with three days lost on account of rain. The adjacent land is very hilly and the natural soil is clay loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 850 feet. The maximum cut was 4 feet, the maximum fill 3.4 feet, and the maximum grade of 15 per cent was reduced to 11 per cent. Gravel obtained during the grading was placed on the road to a width of 21 feet, or a total area of 1,983 square yards. Stone retaining walls were built at several places.

One 18-inch and one 24-inch corrugated-iron pipe culvert were laid.

The total cost of the work, including culverts, was $813.92, or $0.411 per square yard.

SHREWSBURY, VT. (No. 1).—Work was begun on a gravel road about midway between Shrewsbury and North Shrewsbury on June 6, 1913, and completed July 3, 1913. The adjacent land is hilly and the natural soil is clay and rock.

The road was graded 25 feet wide in both cuts and fills for a distance of 495 feet. The maximum cut was 3 feet, the maximum fill 3.9 feet, and the maximum grade of 12.8 per cent was reduced to 7 per cent. A surface of bank gravel was laid 20 feet in width, making an area of 1,100 square yards.

One 24-inch corrugated-iron pipe culvert was laid.

The total cost of the work, including culvert, was $272.34, or $0.248 per square yard.

SHREWSBURY, VT. (No. 2).—Work was begun on a gravel road extending west from Shrewsbury toward East Clarendon on September 15, 1913, and completed October 28, 1913. Three days were lost on account of bad weather. The adjacent land is hilly and the natural soil is clay.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,023 feet. The maximum cut was 2 feet, the maximum fill 4.1 feet, and the maximum grade was reduced from 8 to 6 per cent on the new road. The road was surfaced with bank gravel 21 feet wide, making an area of 2,387 square yards.

One 12-inch and one 18-inch corrugated-iron pipe culvert were laid and one 2 by 2 foot masonry culvert was lengthened.

The total cost of the work, including culverts, was $394.30, or $0.165 per square yard.

SPANKTOWN, VT.—Work was begun on a gravel road extending from Spanktown northwest toward North Pawlet on August 12, 1913, and completed on September 28, 1913. Two days were lost on account of rain. The adjacent land is rolling and the natural soil is clay loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,650 feet. The maximum fill was 0.8 foot.

Telford foundation was laid for 1,000 feet. A surface of gravel 21 feet wide, making an area of 3,850 square yards, was laid in two courses. The bottom layer was obtained from a creek bed nearby and the top coat was of bank gravel.

One 15-inch corrugated-iron pipe culvert was laid; also, one 2 by 2 foot and one 2 by 3 foot masonry culvert.

The total cost of the work was $694.25, or $0.180 per square yard.

SUDBURY, VT.—Work was begun August 8, 1913, on a gravel section running west from Brandon toward Jones's store on Cooks Hill Road and completed on October 15, 1913. Four days were lost on account of rainy weather. The adjacent land is hilly and the natural soil is loam, running to gravel loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 850 feet. The maximum cut was 3.8 feet, the maximum fill 2.6 feet. The grading work was rather heavy and the maximum grade was reduced from 12 per cent to 8 per cent. The road was surfaced with gravel obtained from the cuts and laid to a width of 21 feet, or a total area of 1,983 square yards.

Two 12-inch and one 18-inch corrugated-iron pipe culverts were laid and one 2 by 2 foot masonry culvert lengthened.

The total cost of the work, including culverts, was $888.10, or $0.447 per square yard.

TINMOUTH, VT. (No. 1).—Work was begun October 15, 1913, resurfacing with gravel the road beginning 1,500 feet east of Tinmouth church and extending east toward Wallingford. It was completed October 30, 1913, with one day lost on account of bad weather.

The road was surfaced 18 feet wide for a distance of 825 feet, making a total surfaced area of 1,650 square yards. The bank gravel used was hauled one-half mile.

The total cost of the work was $86.60, or $0.052 per square yard.

TINMOUTH, VT. (No. 2).—Work was begun August 1, 1913, on a gravel road beginning at the creamery in Tinmouth village and extending east toward Wallingford. It was completed on September 20, 1913, with a delay of two days on account of bad weather. The adjacent land is hilly and the natural soil a sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,155 feet. The maximum cut was 3.8 feet, the maximum fill 2 feet, and the maximum grade was reduced from 11.5 to 7.5 per cent. Bank gravel surfacing 21 feet in width was laid, making a total surfaced area of 2,695 square yards.

One 3 by 4 foot masonry culvert was lengthened and one 24-inch corrugated-iron pipe culvert laid.

The total cost of the work, including culverts, was $962.59, or $0.357 per square yard.

Wallingford, Vt. (No. 1).—Work was begun on a gravel road in the village of Wallingford, extending north toward Rutland, on July 5, 1913. It was completed on July 31, 1913, with one day lost on account of bad weather. The adjacent land is rolling and the natural soil is loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,122 feet. The maximum fill was 3 feet and the maximum grade was reduced from 2 to 0.8 per cent on the new road. The road was surfaced 21 feet wide with bank gravel, making an area of 2,618 square yards.

One 12-inch and one 18-inch corrugated-iron pipe culvert were placed.

The total cost of the work, including culverts, was $365.40, or $0.139 per square yard.

Wallingford, Vt. (No. 2).—Work was begun August 3, 1913, on a gravel road beginning one-half mile north of Wallingford in Marsh Woods and extending north toward Rutland. It was completed on August 20, 1913. The adjacent land is rolling and the soil is clay loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 549 feet. The maximum fill was 2 feet and the maximum grade of 2 per cent on the old road was reduced to 1 per cent on the new road. A telford base was laid of stone, which was hauled 2 miles, and this was surfaced with bank gravel which was hauled 2¼ miles. The width of surfacing was 21 feet, making an area of 1,281 square yards.

One 3 by 3 foot masonry culvert was built and one 2 by 3 foot culvert was lengthened.

The total cost of the work, including culverts, was $741.80, or $0.580 per square yard.

Wallingford, Vt. (No. 3).—Work was begun August 23, 1913, on a gravel section 1 mile north of South Wallingford on the Creek Road. It was completed on September 20, 1913, with a delay of two days because of rain. The adjacent land is hilly and the natural soil is partly sand and partly clay loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,500 feet. The maximum cut was 2.8 feet, the maximum fill 2.5 feet, and the maximum grade of 8 per cent on the old road was reduced to 6 per cent on the new road. This work was all rather heavy. The road was surfaced 21 feet wide, making an area of 3,500 square yards.

One 18-inch corrugated-iron pipe culvert was laid.

The total cost of the work, including culvert, was $855.05, or $0.244 per square yard.

Wallingford, Vt. (No. 4).—Work was begun on a gravel road extending west from Wallingford toward Tinmouth on September 22, 1913. It was completed on October 25, 1913, with a loss of two days on account of bad weather. The adjacent land is hilly and the natural soil is sand and loam.

The road was graded 26 feet wide in both cuts and fills for 1,080 feet. The maximum cut was 3 feet, the maximum fill 3 feet, and the maximum grade of

9 per cent was reduced to 6 per cent A short section of hemlock crib was built to hold the embankment. Bank gravel was used for surfacing and was placed 21 feet wide, or a total of 2,541 square yards.

One 24-inch corrugated-iron pipe culvert was laid.

The total cost of the work, including culvert, was $591.85, or $0.233 per square yard.

WALLINGFORD, VT. (No. 5).—Work was begun on a gravel road extending west from Wallingford toward Tinmouth on October 26, 1913, and completed on November 5, 1913. The adjacent land is hilly and the natural soil is clay.

The road was graded 25 feet wide in both cuts and fills for a distance of 660 feet. The maximum cut was 1 foot, the maximum fill 1.8 feet, and the maximum grade was reduced from 3 to 2 per cent. A gravel surface 20 feet wide, making an area of 1,466 square yards, was laid. The average haul was 200 feet.

The total cost of the work was $79.35, or $0.054 per square yard.

WEST PAWLET, VT.—Work was begun October 25, 1913, on a gravel road beginning at the Bennington County line south of West Pawlet and extending north toward Rupert. It was completed November 12, 1913, with a delay of four days on account of rain. The adjacent land is rolling and the natural soil clay loam.

The road was graded 26 feet wide in both cuts and fills for a length of 1,320 feet. The maximum cut was 0.5 foot, the maximum fill 0.8 foot. The maximum grade of 2 per cent on the old road was reduced to 1.5 per cent on the new road. A bank gravel surface was laid 21 feet wide, making an area of 3,080 square yards.

The total cost of the work was $370.52, or $0.120 per square yard.

WESTHAVEN, VT. (No. 1).—Work was begun August 15, 1913, at a point 6 miles northwest of Fair Haven, on a gravel road extending northwest toward Benson. It was completed on September 10, 1913, with one day lost on account of rain. The adjacent land is hilly and the natural soil is sandy loam from station 0 to 2 and clay from station 2 to 12+71.

The road was graded 26 feet wide in both cuts and fills for a distance of 1,271 feet. Only the road machine was used, since very little grading was necessary. A surface of gravel 21 feet wide was laid, making an area of 2,956 square yards.

The total cost of the work was $279.10, or $0.094 per square yard.

WESTHAVEN, VT. (No. 2).—Work was begun August 12, 1913, at a point 3 miles west of Westhaven, on a gravel section extending on the West Road toward Lake Champlain. It was completed on September 6, 1913, with a loss of two days on account of rain. The adjacent land is hilly and the natural soil is clay.

The road was graded 24 feet wide in both cuts and fills for a distance of 743 feet. The maximum cut was 1 foot, the maximum fill 1.5 feet, and the maximum grade on the old road was reduced from 3 to 2 per cent. A telford foundation was laid for a distance of 200 feet. Bank gravel was used for surfacing and placed 20 feet wide, or a total of 1,651 square yards.

One 2 by 2 foot masonry culvert was lengthened and one 12-inch corrugated-iron pipe culvert laid.

The total cost of the work, including culverts, was $276.46, or $0.176 per square yard.

West Rutland, Vt.—Work was begun September 20, 1913, on a gravel road starting 3½ miles west of West Rutland and extending toward Castleton. It was completed October 8, 1913, with a loss of two days on account of rain. The adjacent land is hilly and the natural soil is sandy loam.

The road was graded 26 feet wide in both cuts and fills for a distance of 528 feet. The maximum cut was 2 feet, the maximum fill 1.8 feet, and the maximum grade of 4 per cent on the old road was reduced to 3 per cent on the new road. A surface of bank gravel 21 feet wide was laid, making a surfaced area of 1,232 square yards.

One 3 by 3 foot masonry culvert was lengthened.

The total cost of the work, including culvert, was $265.83, or $0.215 per square yard.

EXPERIMENTAL ROAD WORK.

A portion of the special appropriation for experimental road improvement was used to resurface with limestone macadam the road known as the Rockville Pike, in Montgomery County, Md., and to then treat the surface with various bituminous materials in conjunction with gravel, trap-rock screenings, and limestone screenings. The resurfacing was begun March 15, 1913, and the surface treatment started on September 5, 1913. The work was completed and the road opened to the public on December 17, 1913. In addition to the Rockville Pike, a 1,500-foot section on Bradley Lane, east from the pike, was resurfaced with limestone. The land adjacent to the road is rolling and the natural soil is for the most part a mica clay.

The reports following describe the resurfacing as done under the four contracts into which the work was divided. For a detailed description of the bituminous surface treatments, which were carried out in seven distinct sections, see Department Bulletin No. 105, "Progress Report of Experiments in Dust Prevention and Road Preservation, 1913."

Limestone Macadam Resurfacing.

Contract No. 1, Rockville Pike, Md.—Work was begun March 15, 1913, on the road from station 61+20 to station 210 and was completed August 8, 1913, with a loss of eight days on account of bad weather. The old roadbed was loosened by spikes in the roller wheels and a 3-ton scarifier.

The old macadam was reshaped and a surface of macadam was laid for 14,460 feet, 15 feet wide, making 24,100 square yards. About 248.22 tons of No. 1 stone were used to fill depressions, after which 2,911.75 tons of No. 2 stone were spread 3 inches deep before compacted, and 1,164.31 tons of stone screenings used for a binder course. The stone was shipped on the cars and the haul from the cars to the road was 1⅛ miles.

Ditches were dug to the extent of 20,923 linear feet.

The equipment consisted of three 10-ton steam rollers, one sprinkler wagon, grading machine, dump wagons, gasoline pumps, tanks, small tools, etc.

The road was built by contract for $11,638.14, which is at the rate of $0.483 per square yard. Labor cost $1.70 and teams $4.50 per day of eight hours.

CONTRACT No. 2, ROCKVILLE PIKE, MD.—Work was begun April 25, 1913, on the road from station 0+15 to 61+20, and completed June 17, 1913, with a loss of three days on account of bad weather. A surface of macadam was laid for 6,105 feet, 15 feet wide, making 10,175 square yards. The old macadam road was loosened with spikes in the roller wheels, and a 3-ton scarifier was then used to tear the surface apart.

About 58.35 tons of No. 1 stone were used to level depressions and reshape the old surface, after which No. 2 stone was spread 3 inches deep to the amount of 1,102.8 tons. This layer was then rolled, and about 1 inch of screenings, or 440.7 tons, was spread, watered, and rolled until the surface was completed with a crown of one-half inch to the foot. The crushed rock was hauled from the cars to the road, with an average haul of three-fourths of a mile.

Drainage structures were as follows: Sixteen feet of 8-inch clay pipe; 14 feet of 12-inch clay pipe; 76 feet of 10-inch corrugated pipe. Thirty-three feet of pipe were relaid.

The equipment consisted of two steam rollers, sprinkler wagon, 3-ton scarifier, road machine, gasoline pump, portable tank, and small tools. Labor cost $1.70 and teams $4.50 per 8-hour day. The total cost of the road was $5,753.36, which is at the rate of $0.565 per square yard for surfacing, or $0.339 per square yard for the full width.

The principal items of cost were as follows at contract prices: Completed shoulders, 1,000 linear feet, at $0.15 per linear foot, $150; ditches, 6,000 linear feet, at $0.04 per linear foot, $240; scarifying and shaping subgrade, 10,000 square yards, at $0.06 per square yard, $600; stone in place, No. 1 stone, 58.35 tons, at $2.90 per ton, $169.21; No. 2 stone, 1,102.8 tons, at $2.90 per ton, $3,198.12; No. 3 stone, 440.7 tons, at $2.90 per ton, $1,278.03; 12-inch clay pipe, 14 linear feet, at $0.75 per linear foot, $10.50; 8-inch clay pipe, 16 linear feet, at $0.50 per linear foot, $8; 10-inch corrugated-iron pipe, 76 linear feet, at $0.85 per linear foot, $64.60; drop inlets, at $15 each, $15; lowering drain 33 linear feet, at $0.30 per linear foot, $9.90; inlets into culverts, $10.

CONTRACT No. 3, ROCKVILLE PIKE, MD.—Work was begun June 30, 1913, on the road from station 210 to station 477+89 and completed October 16, 1913, with a loss of four days on account of bad weather. It is estimated about 2,779.1 cubic yards of material were moved in grading the road. The old surface was loosened with spikes in the roller wheels, and a 3-ton scarifier was then used.

A surface of macadam was laid for 26,814 feet, 15 feet wide, making 44,690 square yards. After about 146.95 tons of No. 1 stone were used to level depressions, about 6,377.45 tons of No. 2 stone were spread to a depth of 3½ inches before compacted. This surface was rolled, and 1,651.85 tons of screenings were applied to a depth of 1 inch before compacted, and the surface sprinkled and rolled to a finished surface having a crown of five-eighths inch to the foot. The stone used was a limestone whose binding and wearing qualities are considered good. The material was dumped in long piles from wagons and spread to proper thickness by means of shovels and rakes. It was shipped in on the cars, and the average haul from the cars to the road was 1¼ miles.

Drainage structures were constructed as follows: Station 211+00, 28 linear feet 15-inch corrugated-iron pipe culvert; station 246+00, 26 linear feet 10-inch clay pipe and side drain; station 323+00, 28 linear feet 10-inch corrugated-iron pipe and side drain; station 328+00, 28 linear feet 10-inch corrugated-iron pipe and side drain. End walls were constructed at all pipe ends to fit local conditions.

The equipment consisted of four steam rollers, sprinkler wagons, 3-ton scarifier, road grader, small tools, etc. Labor cost $1.60 and teams $4.80 per 8-hour day. The road was built by contract for $23,704.71, which is at the rate of $0.53 per square yard.

CONTRACT No. 4, BRADLEY LANE, MD.—Work was begun August 4, 1913, on the section of road extending from Wisconsin Avenue toward Connecticut Avenue on Bradley Lane. It was completed September 30, 1913. The road was graded 16 feet in both cuts and fills for 1,530 feet. A surface of macadam was laid for 1,530 feet, 10 feet wide, making 1,700 square yards. The crushed rock was delivered on the cars and hauled to the road, with an average haul of three-eighths mile. The surface of the old macadam road was loosened with spikes in the roller wheels, and torn apart with a 3-ton scarifier. This surface was then reshaped and leveled with No. 1 stone, and rolled, after which 3 inches of No. 2 stone were spread and rolled. About 1 inch of binder course was then spread, watered, and rolled, and the road finished with a crown of one-half inch to the foot.

The road was built by contract for $1,285.72, which is at the rate of $0.756 per square yard. Labor cost $1.70 and teams $4.50 per day of eight hours.

POST-ROAD WORK.

Under the act of Congress of August 24, 1912, making appropriation for the Post Office Department for the fiscal year 1913, there was appropriated $500,000 for the improvement of roads used in rural delivery, in order to ascertain how such improvement would affect the amount of territory served by rural carriers, the increase in number of delivery days, etc. In short, the improvements were to be carried out in such manner as to indicate the relative saving to the Government in the operation of the Rural Delivery Service, and to the local inhabitants in the transportation of their products. The Secretary of Agriculture was appointed to cooperate with the Postmaster General and to furnish the supervision for the construction work, which is being done through the Office of Public Roads. Under the act the local authorities pay not less than two-thirds of the cost of the improvement, and the Federal Government the remaining one-third. A detailed report, containing description and cost data of the work, will be published in a joint report made to Congress by the Secretary of Agriculture and the Postmaster General upon the completion of the work, which comprises the following 17 projects:

Lauderdale County, Ala., 30 miles of earth road;
Boone and Story Counties, Iowa, 51 miles of earth road;
Dubuque County, Iowa, 20 miles of gravel road;
Bath and Montgomery Counties, Ky., 11 miles of macadam road;
Montgomery County, Md., 5.4 miles of macadam road;
Cumberland County, Me., 21 miles of bituminous macadam road;

Leflore County, Miss., 24 miles of gravel road;
McDowell County, N. C., 16 miles of earth road;
Davie, Forsyth, and Iredell Counties, N. C., 48 miles of sand-clay and topsoil road;
Licking and Muskingum Counties, Ohio, 24 miles of concrete road;
Jackson County, Oreg., 51.4 miles of earth road;
Aiken County, S. C., 27.3 miles of sand-clay and topsoil road;
Loudon County, Tenn., 6.4 miles of macadam road;
Montgomery County, Tenn., 7.6 miles of macadam road;
Bexar, Comal, Travis, Hays, and Guadalupe Counties, Tex., 71.6 miles of gravel road;
Fairfax County, Va., 12.3 miles of gravel road;
Spotsylvania, Caroline, and Hanover Counties, Va., 38.2 miles of sand-clay and topsoil road.

BRIDGE WORK.

BRIDGES AND CULVERTS ON POST ROADS.

On the post roads typical designs of culverts and bridges prepared by the office were built wherever suitable for the location, and they are described in the reports of the post roads. In cases where typical designs did not fit the locations, special designs were made in accordance with surveys of the sites, as follows: Alabama, 2; Iowa, 2; Mississippi, 5; Tennessee, 3; Texas, 1; Virginia, 3.

PREPARATION OF PLANS, BRIDGE INSPECTIONS, ETC.

Typical designs were prepared for I-beam bridges with wooden floors for spans from 12 feet to 40 feet, varying in length by 2 feet. Bridge sites were inspected and special designs prepared, as follows: California, 2; Indiana, 2; New Hampshire, 1; North Carolina, 12; South Carolina, 6; Tennessee, 1; Virginia, 1. Final inspections of the bridges referred to above were made in a number of cases for the benefit of local officials. In several cases designs prepared by State highway departments and bridge companies were examined and reports made. Concrete abutments for a steel bridge at Stanley, N. C., were erected under supervision of an office engineer.

WORK OF THE DIVISION OF NATIONAL PARK AND FOREST ROADS.

The Division of National Park and Forest Roads was formed on February 16, 1914, with T. Warren Allen as chief. Arrangements were made early in 1914 for cooperation between the Department of the Interior and the Department of Agriculture, also between the Forest Service and the Office of Public Roads, for the purpose of bringing about the wisest possible expenditure of available funds for road building and maintenance in certain of the National Parks and Forests.

These arrangements provide that when the assistance of a highway engineer for any of the National Parks or Forests is desired, the assignment of such an engineer will be requested of the Office of Public Roads, and such engineer will be assigned by said office whenever it is practicable to do so. The salaries of such engineers are paid from funds of the Office of Public Roads, and their expenses from funds of the Department of the Interior when the cooperative work is within National Parks, and from funds of the Forest Service when the work is within National Forests. All work of construction is paid for from funds of the Department of the Interior or the Forest Service.

WORK DONE IN NATIONAL FORESTS.

In conformity with the agreements made, representatives of the office were placed in five of the Forest Service Districts and in three of the National Parks about the 1st of June, 1914. The men who were placed in the Forest Service Districts spent the first few months in learning conditions and particularly in getting acquainted with the road projects by making field inspections. In some cases, where the importance of the project warranted it, reconnaissance surveys were made. With the information thus obtained, together with data assembled from reports of forest supervisors, lists were made of the most important of the projects in each State, and these lists, showing the projects in the order of their importance, were transmitted through the district foresters to the Forester for his approval. As soon as possible after the approval of the lists, surveys were begun and carried to completion. In practically all of the districts surveys have been made of the projects which will be put under construction during 1915, and plans, estimates, and specifications are being prepared. A small amount of earth road construction was done up to January 1, 1915, but in most cases attention was confined to preparatory work to insure that an orderly progress of the work would be followed out.

SURVEY WORK.

In preparation for construction work, which is described later, the following survey work was done:

COCHETOPA FOREST, COLO.—*Cochetopa Pass Road.*—Nine and one-half miles of location survey was made and stakes driven for the construction work at a cost of $682.21.

ROUTT FOREST, COLO.—*Rabbit Ear Road.*—Eleven and one-half miles of location survey was made, plans prepared, and estimates begun at a cost of $786.76.

UNCOMPAHGRE FOREST, COLO.—*Alpine Road.*—Four miles of location survey was made at a cost of $328.82.

BIG HORN FOREST, WYO.—*Big Horn to Hazleton Road.*—Fifteen and three-tenths miles of location survey was made and work on plans begun at a cost of $816.86.

PALISADE AND TETON FORESTS, WYO.—*Teton Pass Road.*—Eleven and one-tenth miles of location survey was made at a total cost of $531.75.

PALISADE FOREST, IDAHO—*Teton Pass Road.*—Two and three-tenths miles of location survey was made at a total cost of $67.30.

PALISADE FOREST, IDAHO—*Victor Irwin Pine Creek Road.*—Eleven and four-tenths miles of location survey was made at a total cost of $294.48.

RUBY FOREST, NEV.—*Secret Pass Road.*—Four and six-tenths miles of location survey was made at a total cost of $265.45.

DIXIE FOREST, UTAH.—*Modena to St. George Road.*—Fifteen and three-tenths miles of location survey was made at a total cost of $615.92.

SEVIER FOREST, UTAH.—*Panguitch to Tropic Road.*—Nine and five-tenths miles of preliminary survey was made at a total cost of $353.68.

TONTO FOREST, ARIZ.—*Salt River to Pleasant Valley Road.*—Twenty-four and eight-tenths miles of location survey was made and preparation of plans started, at a total cost of $2,044.17.

SITGREAVES FOREST, ARIZ.—*Snowflake to Pinetop Road.*—Twenty miles of location survey was made at a total cost of $772.75.

DATIL AND GILA FORESTS, N. MEX.—*Reserve to Alma Road.*—Forty-four and nine-tenths miles of location survey was made and preparation of plans started, at a total cost of $1,646.43.

JEMEZ AND PECOS FORESTS, N. MEX.—*Espanola to Cuba Road.*—Twelve and four-tenths miles of location survey was made and preparation of plans begun at a total cost of $950.45.

CARSON FOREST, N. MEX.—*Questa to Elizabethtown Road.*—Six and three-tenths miles of location survey was made at a total cost of $410.35.

CALIFORNIA.—Reconnaissance surveys covering a total distance of 209 miles were made in 12 of the forests, at a total cost of $2,216.21.

CONSTRUCTION WORK.

A résumé of the construction work done follows, all of which was done by force account under supervision of this office.

HARNEY FOREST, S. DAK.—Two miles of the Sylvan Lake section of the Deadwood-Hot Springs Road were built at a cost of $4,790.10. This is an earth-surface road, on which was done 10,330 linear feet of clearing and grubbing, mostly 50 feet wide, 5,630 cubic yards of earth excavation, and 634 cubic yards of rock excavation. Nineteen culverts were put in. There is also included in the above expenditure $1,747.45 to complete an adjoining section 1,510 feet in length, work on which was begun in 1913.

COCHETOPA FOREST, COLO.—Nine and one-half miles of the Cochetopa Pass Road were built at a cost of $12,339.69. This is an earth-surface road, on which was done 21,157 linear feet of clearing and grubbing, 66 feet wide, 38,270 cubic yards of earth excavation, and 1,800 cubic yards of rock excavation. Fifty-two culverts were put in.

SAN ISABEL FOREST, COLO.—Eleven hundred and thirty-five linear feet of the North Hardscrabble Road were built at a cost of $1,824.59. It is an earth road with excavation all in solid rock. The work done was in completion of a section begun in 1913.

ROUTT FOREST, COLO.—Three miles of the Rabbit Ear Road were built at a cost of $6,893.11. This is an earth-surface road, and the above work completes the project begun in 1913.

MONTEZUMA FOREST, COLO.—One mile of the Dolores River Road was built at a cost of $887.92. This is an earth road on which there was done 3,700 linear feet of clearing and grubbing, 2,560 cubic yards of earth excavation, 371 cubic yards of rock excavation, and 80 linear feet of corduroy. One log bridge and six log culverts were put in. This work is in extension of a 3-mile section built last year.

BRIDGER FOREST, WYO.—A log truss bridge of three 35-foot spans was built across the Green River at a cost of $60.85. Piers and abutments were of logs with filling of stone.

PAYETTE FOREST, IDAHO.—*Payette River, South Fork Road.*—Two and four-tenths miles of road were built at a total cost of $6,230.74. The road is of earth on which was done 3,294 cubic yards of earth excavation, 6,202 cubic yards of rock excavation, and 42 cubic yards of loose rock excavation. To facilitate rock excavation, there was used on this road an air compressor and a plug drill, driven by a gasoline engine.

IDAHO FOREST, IDAHO.—*Warren State Road.*—This is an earth-surface road on which for 2.1 miles general repair work was done, costing $856.98.

UINTA (NEBO) FOREST, UTAH.—*Santaquin Road.*—This is an earth-surface road on which for 3 miles general repair work was done, costing $545.64. There were 3 miles of clearing and grubbing, 1,050 cubic yards of earth excavation, and 128 cubic yards of rock excavation. Three log culverts were built.

WASATCH FOREST, UTAH.—*Kamas to Stockmore Road.*—This road is of earth and was constructed for a length of 1.7 miles at a total cost of $1,772.86. There were done 1.7 miles of clearing and grubbing and 4,092 cubic yards of earth excavation. Three log bridges were built.

POWELL FOREST, UTAH.—*Escalante to Winder Road.*—An earth-surface road was constructed for a length of 4 miles at a total cost of $4,845.15.

KAIBAB FOREST, ARIZ.—*Grand Canyon Highway.*—An earth-surface road was constructed for a length of 1.9 miles at a total cost of $1,829.14.

RUBY FOREST, NEV.—*Toyn Canyon Road.*—The work on this road consisted in making the existing road from 2 to 4 feet wider at a total cost of $524.49.

RUBY FOREST, NEV.—*Harrison Canyon Road.*—An earth-surface road was constructed for a distance of three-tenths of a mile at a total cost of $380.85. There was done 0.3 mile of clearing and grubbing for a width of 24 feet, 2,300 cubic yards of earth excavation, 78 cubic yards of rock excavation, and 200 linear feet of ditching.

HUMBOLDT FOREST, NEV.—*Gold Creek to McDonald Road.*—General repair work was done on 6 miles of existing earth road at a total cost of $391. In addition to the grading done six log culverts and one log bridge were built.

HUMBOLDT FOREST, NEV.—*Gold Creek to Jarbidge Road.*—General repair work was done on 1 mile of existing earth road at a total cost of $54.

HUMBOLDT FOREST, NEV.—*Mountain City to Aura Road.*—General repair work was done on one-quarter mile of earth-surface road at a total cost of $201.

KLAMATH FOREST, CAL.—*Seiad Trail.*—Three miles of trail were built up Seiad Creek to connect with a trail built in the Crater Forest in Oregon. The total cost was $801.

TRINITY FOREST, CAL.—*Trinity River Road.*—A contract was made for $410 to clear off approximately 1,500 cubic yards of earth from slides on the portion of the road built last year.

Work was also done in the States of Oregon and Washington. In addition to the above minor repair work was done as follows:

COCHETOPA FOREST, COLO.—Cochetopa Pass Road, $112.87.
BIG HORN FOREST, WYO.—Buffalo to Hazleton Road, $25.22.
ROUTT FOREST, COLO.—Rabbitt Ear Road, $56.63.

WORK DONE IN NATIONAL PARKS.

Representatives of the office were placed in Sequoia, Yosemite, and Glacier National Parks, and survey work was carried on in each one of these with the idea of continuing the work until surveys have been made and plans and estimates prepared for a complete road system for each of these parks.

In the Yosemite survey work has been completed on a road from the westerly boundary of the park near the railroad terminal at El Portal easterly up the valley of the Merced River, through the village of Yosemite to the top of the Nevada Falls, a distance of about 21 miles. Plans and estimates for this road are being prepared in 5-mile sections, and they have been completed for section No. 1, which begins at the aforesaid westerly boundary line. The cost of this work to December 31, 1914, was $3,131.23, or $149.10 per mile.

A topographical survey was made of the floor of the valley to show contours at intervals of 2 feet. This survey was made for the purpose of establishing a new village site and working up a development scheme for this portion. The area covered is about 3 square miles, and the cost $332.60, or $110.87 per square mile.

In the Sequoia Park a survey was made from the Giant Forest by way of Wolverton Creek, the Marble Fork of the Kaweah River, and Willow and Cahoon meadows to the north boundary of the park near J. O. Pass, a distance of about 10 miles. The plans and estimates for this road are being prepared in sections. Section No. 1 extends from the Giant Forest to the crossing of the Marble Fork. In addition to this 13.5 miles of level line were run over the park entrance road. The total cost of the work done in Sequoia Park is $2,233.60.

In Glacier Park a survey was made for a road from the mouth of Fish Creek at Lake McDonald northwesterly to McGee's meadow on the road along the easterly side of the North Fork of the Flathead River, a distance of about 5 miles. Plans and estimates are being prepared for this road. A survey was also begun for a road from the mouth of Fish Creek northerly along the westerly side of Lake McDonald, but the work was interrupted by winter weather when about 4 miles of the survey had been completed. This survey along the lake will be extended northerly to the head of the lake and from there northerly to Waterton Lake and along it to the northerly boundary of the park, which is also the boundary line between the United States and Canada. The total cost of the work done in Glacier Park to January 1, 1915, is $1,700.99.

WORK OF DIVISION OF MAINTENANCE.

The maintenance work of the office was separated and a division formed on February 16, 1914, with E. W. James as chief. At that time some experimental maintenance for purposes of securing cost data was being conducted on 8 miles of road in Alexandria County, Va., under a memorandum of agreement with the county authorities, and plans were being considered for maintaining the experimental roads built by the office in Montgomery County, Md.

On the organization of the division the following lines of work were planned. They are all continuous projects within the limits noted.

I. STUDY OF THE DETAILS OF ROAD MAINTENANCE AS CARRIED OUT BY STATE AUTHORITIES IN REPRESENTATIVE STATES.

The work under this head will enable the office to draw from the experience of the most advanced and efficient highway organizations in the country the results of their experiments and endeavors, and to extend this information by correspondence and actual demonstration to those communities where improved roads have been built at large cost and are deteriorating more or less rapidly, because of lack of organization, information, and skilled supervision in matters pertaining to road maintenance. The studies are being made in a number of States having well-organized highway departments, such as Massachusetts, New Hampshire, Connecticut, New York. This work has so far been limited to short studies in the first and third divisions of Massachusetts, the first division of New York, the ninth and part of the sixth division of New Hampshire.

Preliminary inspections were made covering general organization of maintenance force and the system of roads under maintenance. Some general details of average costs and general resurfacing methods were included. The smaller and more intimate details of the work will require personal studies in the field with construction gangs for a considerable period of time.

II. STUDY OF THE DETAILS OF COUNTY MAINTENANCE IN SELECTED COUNTIES.

To extend maintenance investigations into regions which have no State organization but still depend entirely on the county system of road administration certain counties are to be studied which have constructed improved roads on a large scale. No work has yet been done in this line, but plans are being made to do work in Allegheny County, Pa.; Montgomery County, Ala.; Hines County, Miss.; Hillsboro and Duval Counties, Fla. The Division of Road Economics will cover details of organization in county road maintenance and to that extent cooperate with this division.

III. INAUGURATION OF MAINTENANCE ON POST ROADS CONSTRUCTED UNDER ACT OF CONGRESS OF AUGUST 24, 1912.

On the maintenance of all post roads constructed under the act of August 24, 1912, the office furnishes advice and where possible exercises supervision.

Maintenance under a county engineer is now systematic on the Virginia post road in Spotsylvania County and on the completed part of the Ohio post road. This work involves the keeping of accurate costs to determine the annual cost of maintenance per mile. Plans are being made to extend this maintenance to post roads in Maine, Tennessee, Texas, and Alabama.

IV. SUPERVISION OF MAINTENANCE ON A ROAD FROM WASHINGTON, D. C., TO ATLANTA, GA.

Demonstration road maintenance is being conducted on the Washington-Atlanta Highway from Petersburg, Va., southward. The purpose of this work is principally to demonstrate maintenance methods and the value of road maintenance in increasing not only the number of days in the year that an earth or sand-clay road can be kept in good condition, but the extent to which the wear of gravel, macadam, and other types may be counteracted by ordinary methods of maintenance. As the work continues, the demonstration is developing the following facts, which are here enumerated without comment. It is expected that further work will provide more corroborative data for very valuable observations with reference to local road administration.

1. County boards, although having full administrative authority, appear not to attach to their official action in road matters the importance or legal effect which it should have.

2. County boards do not generally have sufficient accounting control of road funds to know what is available for any particular project—where funds have been, or where existing balances are to be, expended.

3. Lack of any systematic practice in handling road funds among most counties makes it very difficult to carry out over even a single year any persistent maintenance policy, because funds officially obligated for maintenance purposes are not protected against sporadic and irregular draughts for miscellaneous purposes. The greatest likelihood consequently exists everywhere that there will be no balance in the maintenance fund in the last half or third of the year, although only a part of the fund allotted may have been spent.

4. Local labor available for maintenance work is made dissatisfied by the constant, unintelligent, and unfavorable criticism of those using the road.

5. Maintenance continuing over a period of years—the ultimate indispensable condition of effective maintenance—is jeopardized by the lack of accounting control that prevents spending next year's current income in this year.

6. The lack of skilled supervision in construction and the effect of this in increasing the cost or in making effective maintenance impossibly expensive are everywhere seen.

7. The county authorities are commonly opposed to following suggestions for maintenance that involve tying up road funds in any way, such as purchasing materials in advance to store along the road for making repairs or maintaining the road surface.

All of the above matters are quite apart from the customary expected difficulties encountered in practical details of maintenance, and the elimination of many of these perplexing matters can apparently only follow some educational propaganda and a general enlightenment of county voters and officials. These troubles are not all found in any one county, but no county is entirely free from all.

These matters will be made the basis for special study, with a view to suggesting detailed, effective remedies so far as they can be applied under existing conditions and to promoting a better understanding of the imperative needs of maintenance to conserve the huge investment of public funds being made annually in county road construction.

A total of 681.8 miles is now under the supervision of this office. This is about 81.2 per cent of the distance from Petersburg to Atlanta and 69.1 per cent of the total distance from Washington to Atlanta on the selected route. A large number of companion photographs have been taken showing the condition of this road at the time the Government supervision commenced, and again after improvement.

Table I shows the distribution of mileage in the several counties, the mileage under patrol squads or gangs, and the amounts expended for maintenance and construction. All the work is cooperative and the counties which are participating in the plan first signified their concurrence in the project by adopting and recording a resolution establishing the legal status of supervision by the Government. The counties then made application on a form provided by the office. When these were properly executed they were then filed in the Washington office.

TABLE I.—*Maintenance and construction funds expended, mileage, etc., Washington-Atlanta Highway.*

No.	County.	State.	Total mileage in county.	Mileage under Government supervision.	Construction funds expended to Dec. 31, 1914.	Allotted for maintenance.	Spent for maintenance to Dec. 31, 1914.	Mileage on which construction has been done.	Mileage under patrol.	Mileage under squad.
1	Dinwiddie	Virginia	28.1	28.1	$1,156.89	$2,010.00	$1,376.52	2.0	28.0	
2	Brunswick	do	30.0	30.0	1,428.00	1,050.00	362.03			30.0
3	Mecklenburg	do	44.0	29.0	300.00	575.00	340.50	2.0		27.0
4	Granville	North Carolina	35.0	35.0	8,368.58	2,100.00	975.88	4.0	35.0	
5	Durham	do	23.0	23.0	7,398.19	2,000.00	900.57	1.0	23.0	
6	Wake	do	41.0	41.0	5,457.57	3,000.00	844.37	6.0	41.0	
7	Johnston	do	33.0	17.0	1,068.59	1,500.00	313.90	2.0	15.0	[1] 15.0
8	Harnett	do	10.0	10.0	2,400.00	500.00	66.65	4.0		10.0
9	Cumberland	North Carolina, north half.	21.0	18.0	1,375.00	1,600.00	983.34	1.0		18.0
		North Carolina, south half.	12.1	12.1		(2)	136.00		12.1	
10	Hoke	North Carolina	26.2	26.2	2,046.95	1,600.00	200.00	16.0		26.2
11	Moore	do	22.4	20.7	267.00	1,655.00	746.75	3.0	20.7	
12	Montgomery	do	1.6	1.6					1.6	
13	Richmond	do	32.8	32.3		1,600.00	467.50	20.0	32.3	
14	Marlboro	South Carolina	9.1							
15	Chesterfield	do	35.3	32.7	8,333.23	1,700.00		32.7		
16	Kershaw	do	38.0							
17	Richland	do	18.5	15.3		650.00	1,010.50			15.3
18	Lexington	do	31.6	29.0	724.46	1,040.00	626.16	3.0	29.0	[1] 10.5
19	Saluda	do	4.3							
20	Aiken	do	40.2	38.2		1,850.00	691.50		25.2	13.0
21	Columbia	Georgia	8.0		659.40					
22	McDuffie	do	28.5	28.5	1,992.39	1,300.00		9.0		
23	Warren	do	17.7	17.7	2,067.90	1,045.00		12.0		
24	Wilkes	do	28.8	28.8	6,230.00	1,300.00		4.0		
25	Taliaferro	do	12.6	12.6	2,134.40	600.00		12.5		
26	Oglethorpe	do	19.4	19.4		900.00				
27	Greene	do	24.1	24.1	1,819.75	1,300.00		2.5		
28	Clarke	do	18.3	18.3	1,289.50	1,000.00				
29	Oconee	do	6.8							
30	Walton	do	27.9	27.9	1,505.00	1,000.00		2.5		
31	Morgan	do	20.1	20.1	479.60	1,000.00		0.5		
32	Newton	do	16.6		4,950.00			7.0		
33	Rockdale	do	9.4							
34	Gwinnett	do	16.6		376.20			2.0		
35	Dekalb	do	28.8	28.8	9,227.60	1,250.00		4.5		
36	Fulton	do	3.3							
37	Richmond	do	16.4	16.4	2,729.75	950.00		0.5		
	Total		840.5	681.8	75,785.95	36,075.00	10,042.17	153.7	262.9	139.5

[1] Both patrol and squads.

[2] As needed.

The work of maintenance is being done by patrolmen and gangs. Patrolmen have sections that vary in length from 6 to 29 miles. The average in the northern section is 12.9 miles, and in the central section 10.8 miles. Some of these patrol sections are too long, but funds were not available to provide any more men.

The usual maintenance work on earth and sand-clay roads includes:

(*a*) Dragging persistently at every available opportunity;

(*b*) Using the grading machine when necessary;

(*c*) Filling depressions;

(*d*) Adding sand or clay as required;

(*e*) Removing all trash, tin cans, nails, old iron, bottles, etc., that accumulate in somewhat astonishing quantities;

(*f*) Replacing broken floor boards in culverts and bridges;

(*g*) Keeping culverts open;

(*h*) Clearing ditches and shoulders;

(*i*) Cutting grass and weeds;
(*j*) Trimming brush and trees at curves;
(*k*) Harrowing and dragging rough or irregular sections;
(*l*) Painting guard rails and culvert heads; and
(*m*) Posting roads.

Records are being kept of locality of expenditures, so far as possible, by using the county financial records supplemented by private notes and the report cards of the patrolmen. A statement of the cost per mile of work on each patrol section will be possible in a later report, but at the present time only one or two counties have spent more than 55 per cent of the allotted funds.

The condition of the road under maintenance has been good during the entire period up to December 23. At about that time the range of temperature in North Carolina and Virginia became such as to cause alternate freezing and thawing, and heavy rains caused swollen streams throughout the entire territory. These conditions at once showed the weak places in the roads. Drainage is prevalently insufficient. This is, of course, largely a structural defect that ordinary maintenance can not cure. Especially has the need of subdrainage been demonstrated. This is almost invariably neglected in the region traversed by this road.

In many sections it has become apparent that the common earth road is not adequate to accommodate the prevailing traffic. During the best weather and during ordinary summer rains no trouble develops, but average protracted rains cause the roads to break up faster and deeper than maintenance can repair them under the continuous stream of traffic.

Since many of the roads along the route were subjects, not for maintenance, but for actual construction, it was necessary, in the preliminary estimates, to include the cost of minimum improvements in all cases where such work was necessary in order to get the roads ready for maintenance. This has led to a great deal of new construction and much reconstruction and repair in each State along the line. The nature of this work has ranged all the way from minor bridge and culvert repairs to the expenditure of bond issues on systematic new construction. The table shows the amounts expended in the various counties in construction under the general supervision of the Government engineers detailed to the project. One assistant has been almost constantly in the northern section giving undivided attention to this work. It is not necessary to itemize the various improvements made, further than that they include all lines of highway work except hard surfacing. Bridges have been relocated and rebuilt or renewed; new roads laid out and graded; earth roads have been surfaced with sand-clay or topsoil; grade crossings have been eliminated by overpasses, underpasses, or relocations; roads have been straightened and widened; culverts have been located, built, and enlarged. The total amount expended in such work up to December, 1914, was $75,785.95, and about $125,000 was available in the fall for continued work. The local financial conditions resulting from the state of the cotton market during the autumn may considerably reduce this figure before it is spent.

V. SUPERVISION OF MAINTENANCE IN ALEXANDRIA COUNTY, VA., UNDER EXISTING AGREEMENT, AND ON THE UNITED STATES EXPERIMENTAL ROADS IN MONTGOMERY COUNTY, MD.

The maintenance of the experimental roads in Montgomery County, Md., is reported in detail in Department Bulletin No. 257. A system of columnar accounts was devised and used to control costs on each of the several experimental sections. The purpose of this work is to demonstrate comparative costs of maintenance on a large variety of surface treatments.

The maintenance of earth roads in Alexandria County, Va., for the purpose of obtaining cost data was started under the Division of Construction on December 30, 1911, and was transferred to this division in February, 1914. Under the present memorandum of agreement it will be continued until June 30, 1915. There have been some changes in the route, and for purposes of better distributing the costs and disclosing any differences that might exist in the general demands of traffic on the different parts of the road it was divided into the following sections:

	Miles.
1. Mount Vernon Road from Hume Station, on the Washington-Virginia Railway, to Nauck over the Old Factory Road	1.7
2. Seminary road from county line to Columbia Pike over the Glebe Road	3.15
3. Hatfield or Fort Myers Road from Hatfield Station, on the Falls Church electric line, to Arlington post office, on the Columbia Turnpike	1.11
4. Balston Road from Columbia Turnpike northward	.51
Total	6.47

Table II shows the entire cost of the work up to January 1, 1915.

TABLE II.—*Cost of maintenance work on 6.5 miles of earth and gravel road in Alexandria County, Va.*

Sections.	Work on surface.	Work on slopes.	Work on ditches.	Miscellaneous and general.	Gravel used.	Total.
					Cu. yds.	
1	$76.91	$34.25	$39.25	$90.07	19.5	$240.48
2	192.04	74.25	219.75	256.26	45.75	742.30
3	55.00	21.75	16.25	53.51	12.00	146.51
4	66.05	14.25	26.75	67.16	22.75	174.21
Total for July 1, 1913, to Dec. 31, 1914	390.00	144.50	302.00	467.00	....	1,303.50
Fiscal year 1912	153.44	61.78	169.88	49.89	....	434.99
Fiscal year 1913	283.68	89.28	198.00	185.04	....	756.00
Total to date	827.12	295.56	669.88	701.93	....	2,494.49

A total of 922.66 miles has been dragged once at a total cost, included in the surfacing charges, of $180.01, which is at the rate of 19.5 cents per mile dragged. In dragging, the average operation has been three and one-half trips over the section.

The cost of maintenance per mile has been $141.46 on section 1; $235.33 on section 2; $131.99 on section 3; $341.59 on section 4, or a weighted average of $201.47 per mile for the whole road.

During the entire year 1914 these roads continued to improve in cross section and condition. Section 2 was ditched over nearly its entire length and much ditching was done along parts of other sections. The county grading machine was borrowed and operated at Government expense for four days in the early fall. Up to December 23, 1914, the time of last inspection, the roads remained in excellent condition and at that time were much better than in May and June.

This experimental work serves to secure cost of dragging, to determine the cost of maintenance that fully meets the wear of traffic on earth and cheap gravel roads, and to demonstrate that earth roads can actually be improved by a regular system of maintenance.

VI. SUPERVISION OF MAINTENANCE ON SOME TYPICAL ROAD IN COUNTIES THAT HAVE RECENTLY CONSTRUCTED A SYSTEM OF HIGHWAYS.

This project is to encourage and promote systematic, intelligent, effective maintenance methods and to assist in devising a scheme for maintenance administration in the county. Owing to the wide distribution of the available roads, this project can not be advanced until a larger organization is developed.

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